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THE CONVERGENCE OF EVOLUTION AND FUNDAMENTALISM

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I

At the close of the first quarter of the twentieth century, it is interesting to compare the status of the theory of evolution with that at the beginning of the century. We even hear it asked whether the theory is solvent or insolvent. As for Darwinism, a separate account of its stock is being taken, with the fear that its solvency may be less than that of the general theory. A cursory survey of the situation seems to show that while the mere fact of evolution has become more and more evident as the years have gone by, nevertheless perplexities have continually multiplied. It has long been recognized that the causes of evolution are unknown, but it is only recently that we are beginning to realize that its method is in doubt and its significance not clear. Even the fitness of the word has lately been doubted, the strange question arising whether the changes and processes included by writers of the nineteenth century under the term "evolution" might be more aptly described by some other name.

Meanwhile biologists are not concerning themselves greatly with the theoretical problem but are entering upon a period of experimental work in genetics, which in respect to its patience and thoroughness compares with the memorable work of Darwin himself seventy-five years ago. In the years to come the puzzles of evolution will no doubt be solved, but at present we are much in the dark. The note of caution is the dominant note among those who are still writing on the theoretical problem. Post-war experiences have put a damper on the buoyant Spencerian optimism of the nineteenth century, while the recrudescence of the religious controversies has come as a kind of shock to those who had taken it for granted that these ancient differences had long been settled. It was truly a strange sight to those of us who recall the controversies of the latter part of the century to see at this late day scientists of the very highest rank entering the arena of the press to enumerate the evidences of evolution to a skeptical and impatient public. One wondered what had happened. A brief review will show what did happen.

When first the theory of evolution burst upon the world in the nineteenth century, it was the simple story of the continuity of plant and animal life. It was the story of the genetic relationship of plant and animal species, showing that all such species might have originated by descent from very simple forms of life. This innocent doctrine, long anticipated before Darwin's day, suddenly

assumed a tremendous importance and aroused an absorbing interest when Darwin marshaled his arguments to show that man—body, mind and morals—is to be included in this history. Then followed a violent controversy, since the new theory touched human traditions in a delicate spot, namely, in that of religious faith. At the close of the century, however, the Darwinian view, so far at least as it relates to animal species and the human body, prevailed. It was almost universally accepted by men of science. It had penetrated the literature of all cultured nations. It had settled down nearly to the lowest strata of popular thought. It had even reconciled itself with religious faith. The "ascent of man" from the lower forms of life was seen to add to his worth and dignity rather than to detract therefrom. It was believed that the religious attitude was greatly strengthened by the enlarged vision opened in evolution. Indeed a poet laureate sang:

> This is my loftiest greatness
> To have been born so low.
> Greater than Thou the ungrowing
> Am I that forever grow.

Straightway the notion of evolution was still further extended. We began to hear of inorganic evolution, cosmic, astral, geologic and atomic. Even the "delirious electrons" evolved into atoms, and matter itself was the product of a process of development. Social evolution had already made its appearance, and we learned that the new law applied also to the development of language, ideas, beliefs, the family, the church and the state, and to individual, social and political institutions. In fact, in those days of first enthusiasms, it occurred to no one that there is any realm of reality at all excluded from the field of evolution. Nothing is fixed or final; nothing is created; everything "just growed." Therewith was born a new and indeed fruitful and wonderful method of study, namely, the genetic method, which increased amazingly our understanding of things by revealing their genetic origins.

Then still another step was taken. Evolution was identified with progress.[1] A period of dizzy optimism followed. Every stage of evolution was "higher" and "better" than the preceding. Our path was "upward." Looking back we look "down." Just before the war human complacency knew no bounds. The industrial revolution had put us in possession of undreamed of power over nature. Time and space, water and air no longer imposed limits. Epidemic diseases could be overcome. Alcohol was to be abolished and crime thereby lessened. Votes for women were to purify our politics. Peace societies and arbitration treaties were to do away with war; and even when war was justified, it was in the same optimistic faith in progress through evolution, since the strong and cultured nations would through their warlike struggles demonstrate again the survival of the fittest. And, finally, it was thought that when human invention had been still further perfected and wealth still more heaped up, it would be necessary only to find some political device by which this wealth could be equally distributed—and behold a millennium.

Then came the crash. But the war was not the crash. For it was the war which was to end war and redeem the world for that ideal government called democracy. It was after the war that the trouble began. Neither states nor individuals behaved in that approved manner which we were led to expect. Rather there were national hatreds and suspicions and a sickening exhibition of individual avarice and greed. In Amer-

[1] In one sense purely physical evolution does include the element of progress. The subject is fully discussed by Lotka in his "Elements of Physical Biology," Chap. II. He defines evolution as "the history of a system undergoing irreversible change."

ica the bartender was banished, but the no less unsavory smuggler and bootlegger took his place. Crime was increased rather than lessened. A certain cultural refinement in manners and morals, gained through the ages with infinite labor, was suddenly lost. Women were coarsened, aping the men in their smoking and painting their faces after the manner of our savage ancestors. Indecency appeared on the stage and vulgarity on the pages of our popular fiction; and even the purity of the family, one of the foundation stones of a healthy social order, was violated by the increasing moral laxity and the ease and frequency of divorce. Almost over night, it seemed to the present writer, whose own memory of these cultural struggles extends back over fifty years, the bright faith in the future encouraged by the theory of evolution turned to fear and distrust. Books and articles suddenly appeared questioning the identity of evolution and progress, and questioning both progress and evolution. We heard all at once of the possible approach of a second dark age, of civilization at the crossroads and of the threatened collapse of our whole modern culture.

We can begin to understand, therefore, why it is that serious thinking people have turned a searching inquiry upon the whole theory of evolution itself. We can even understand why it is that a movement called "Fundamentalism" swept the country, invading our churches and our schools and even our legislatures, a movement in which the whole theory of evolution was questioned.

At first this fundamentalist movement seemed very incongruous. In a time like this it would appear that the fundamental things are honesty, temperance, purity and obedience to the laws of the state, rather than certain beliefs regarding the genealogy of man. To make a point of controversy of the latter seems like going rather far afield for trouble. Consequently, the suggestion has been made that fundamentalism was not due to any kind of religious intolerance but to a sort of dismay which serious and earnest religious workers felt in the presence of the threatened collapse of morals among our people, young and old. Something must be done. Let us fly back to both the faith and the moral virtues of our fathers.

Probably there is truth in this explanation of the fundamentalist movement. But perhaps the explanation is in part even simpler than this. Possibly it was to some extent a reaction against the superficial evolutionary optimism of the earlier years, together with a protest against a too careless and general application of Darwinism to every field of human thought and enterprise.

In part, also, it was a form of protest against certain materialistic and mechanistic interpretations of the doctrine, not shared by its original teachers and not necessarily involved in evolution at all, but rather noisily proclaimed by later disciples.

But at this stage of the agitation something else happened, adding weight to the fundamentalist's position. There appeared on the part of the evolutionists themselves a certain doubt and hesitation affecting some aspects of the theory, while certain utterances of distinguished biologists were interpreted as reflecting upon the theory. Really this doubt and hesitation did not involve the fact of evolution, the evidences for which had steadily increased, but they did apply to its causes and method, and particularly to the validity of that particular theory which goes by the name of "Darwinism." Thus it is easy to understand the new leverage which this gave to the party of opposition. It was possible to question the whole doctrine and to fall back upon the older theory of special creation, which was thought to have the support of religion and the Bible.

II

It may be worth while in the present article to review some of the limitations of the general theory of evolution as the twentieth century has revealed them and to inquire as to its real meaning. Incidentally, the inquiry may bring out some unexpected points of convergence between views which hitherto have seemed wholly contradictory. Such an inquiry will naturally limit itself to organic evolution, although a passing reference may be made to the question whether anything answering to the name *evolution* occurs in other fields.

Even in organic evolution an initial difficulty appears, and this is the question of the applicability of the word itself to the processes described. Literally the word *evolution* means an unrolling process, a process of unfolding, by which the implicit becomes explicit. Although Bateson in an address some years ago did actually propose such a theory, it was never taken very seriously by the scientific world, and perhaps was not intended to be so taken. Such a view would be attended by the blankest mystery. Evolution as it appears in the actual world is just the opposite of an unfolding process. Even the simplest Darwinian variation, much more a mutation, is a real increment, a novelty, a new creation, a veritable plus. I shall refer again presently to this all-important fact. Here it is sufficient to say that evolution is essentially an epigenetic, or building-up process, rather than an unfolding process.

Returning then to our discussion of the causes, manner and meaning of evolution, we may say at once that as regards its causes, they are unknown. It is only in the popular mind that the struggle for existence, heredity, variation and natural selection are regarded as the causes of the development of life. According to Darwin's hypothesis, if we grant the struggle for existence, that is, life and its insurgency, and if we grant heredity, and if we grant variation, why then we can understand the *manner* of evolution, because advantageous variations would be preserved by natural selection.

The anthropomorphic character of the word "selection" has now come to be well known. Selection implies discriminative appraisement. What we have in Darwinian evolution is the disappearance of unadaptive forms. There has also in recent years been a good deal of misunderstanding in the popular mind about heredity. Biologists who lecture on the Mendelian laws and the continuity of the germ plasm probably have no intention of claiming that these laws really explain the ultimate mystery of reproduction and heredity, but they are often so understood. The Mendelian laws, which have indeed completely revolutionized the study of genetics, reveal in a wonderful way the method of distribution of characters in the offspring, but of course do not explain why the offspring resembles the parent. Indeed, Mendel's laws, as Professor Caullery points out, actually embarrass us a good deal in the study of evolution, since they relate to the distribution and combination of factors already existing.[2] Likewise, it is only in the popular mind that Weismann's theory of the continuity of the germ plasm explains heredity. There is, of course, no actual continuity of the germ plasm from generation to generation, since the germ plasm is constantly increased, one codfish perhaps producing millions of eggs, and in this increase the whole mystery of heredity is involved. It is only the form that is actually continuous from generation to generation. The new form resembles the old. Heredity is resemblance. And so it is with variation and the struggle for existence. The causes of both are unknown. The struggle for existence is merely another

[2] See M. Caullery, "The Present State of the Problem of Evolution," Annual Report of the Smithsonian Institution, 1916, p. 332.

name for the insurgency of life, and life is insurgent because it is life.

Concerning the *manner* of evolution, we find at the close of the first quarter of our new century a disheartening uncertainty. It is just here that the last twenty-five years have seen the greatest change, and this change is manifest in the growing disappointment with the Darwinian selection theories. Keeping in mind that Darwinism is merely one of several theories as to the manner in which organic evolution has taken place, we must remember that the growing distrust of the Darwinian hypothesis does not indicate any distrust of the fact of evolution. Darwin's selection theories were most brilliant, ingenious and captivating. They completely won the scientific world, and a quarter of a century ago there were few who doubted their adequacy. In fact, we may say that there are few biologists to-day who would belittle Darwin's contribution or cast doubt upon the value of the theory of natural selection. But as a complete description of the method of evolution, it is very disappointing and as an explanation it sadly fails. That new species have arisen merely by the natural selection of small chance variations is a belief that is far weaker to-day than twenty-five years ago and appears to be steadily losing ground.

If, however, Darwin's selection theory still constituted a workable hypothesis, then our interest would be immediately transferred to the assumptions upon which the theory depends, namely, the struggle for existence, variation and heredity, none of which is understood. The latter fact does not, of course, in itself weaken the value of Darwin's theory, since the struggle for existence, variation and heredity are real facts. It only weakens the vast claims that have been made for Darwinism in explaining the present world of living beings, and it should be remembered that Darwin himself made no such vast claims. They are legends which have gradually grown up.

Since the valuable work of De Vries in the study of mutations, the mutation theory has to some extent supplanted Darwin's theory of small variations. Mutations are simply large variations. According to present-day biological nomenclature, all heritable variations are called mutations. The mere machinery of evolution remains the same as in the Darwinian plan. Mutations that are advantageous in the struggle for existence are preserved by natural selection. If, however, the mutation theory were used to explain the origin of species apart from the Darwinian theory, then the mutation theory could hardly be distinguished from so-called special creation. New species just appear. But if the mutations are simply to take the place of the original small chance variations, then the difficulty in explaining variations is intensified in the case of mutations. Darwin expressed great perplexity as to the cause of variations. What then would he say as to the cause of mutations? As regards the workableness of the mutation theory, it has some advantages over the theory of small variations, although difficulties enough remain. But as for explaining the present world of living beings, it stands just where the Darwinian theory stands, except that the embarrassment which Darwin felt about the cause of variations becomes amazement when we reflect upon the cause of mutations. On the whole, the mutation-selection theory as it stands at the present is a very doubtful explanation of the origin of species: that is, of the origin of the species that exist and have survived in nature.

Other theories of organic evolution than Darwin's are awakening interest to-day, but they have not passed out of the stage of speculation. Lamarck's theory commands new interest, as do the various orthogenetic theories. Lamarck introduced the important idea of the in-

fluence of desire and effort on the part of the organism in determining the direction of evolution. Here we have one of the causes of evolution clearly expressed. Lamarck's theory is not strictly a theory of evolution according to the exact meaning of the term, but it may be called a theory of development; while that of Darwin is neither evolution nor development. Evolution means unwrapping, the implicit becoming explicit. By development is meant the revelation of the successive phases of something in which there is a manifest unity.[3] It is the potential becoming actual. In Aristotle's metaphysics there is outlined a wonderful theory of the world that is distinctly developmental. Both Aristotle and Lamarck proposed theories of evolution which carried with them at the same time a kind of explanation of evolution, which Darwin's theory did not. A Lamarckian might indeed well adopt the Aristotelian view of the world as a great movement in the realization of ideal species and of higher values.

III

It appears, then, at the close of the first quarter of the century, that while the fact of evolution is not in doubt, the belief in it being firmer to-day than ever before, neither the causes of evolution nor the manner are known. Let us consider finally the *meaning* of evolution. Since neither the causes nor the method of evolution are known, evidently it means nothing more than that there are gradual changes in living forms in the direction of greater specialization and greater adaptation to the environment. Since such changes are going on before our eyes at the present time in plant and animal organisms and in the human mind and human affairs, there would not seem to be much ground for controversy here. To be sure, we should not put too much emphasis upon the word "gradual" in the above definition, since abrupt mutations are now emphasized more than the gradual small variations. It would seem necessary only to have the abrupt mutations abrupt enough, and the views of the evolutionists and of the special creationists would merge.

Since, then, evolution means nothing more than changes in plant and animal species in the direction of specialization and adaptation, it behooves us to ask concerning the meaning of these changes, and here another significant fact already referred to needs to be brought into the focus of attention. We have seen that the process of development is not an unrolling process, in which the implicit is merely becoming explicit. It is rather a building-up process in which something new is being constantly added. The whole movement should be called an epigenesis rather than an evolution. But the change in nomenclature can not be made, for the word *evolution* glides from the tongue with astonishing ease, involving, as some one has said, like the corresponding German word *Entwickelung*, all the elements of our vocal apparatus in a most harmonious manner, while the word "epigenesis" is harsh and forbidding. Furthermore, the word epigenesis in biology has a technical meaning debarring it from general use.

To be sure, the claim might be made, and indeed has been made, that the whole evolutionary process *is* one of unfolding, a kind of unwrapping, all later forms of life being present potentially in the amoeba; but the only possible argument for this view would be that since everything has come out of the original simple forms of life, everything must have been potentially present in them. But perhaps everything has not come out of these simple living forms. This is a pure assumption. Possibly something has been added all the way along.

[3] A logical analysis of the concept of evolution and of development will be found in "The Concept of Evolution," by H. W. B. Joseph, Oxford, 1924.

We speak of the evolution of the automobile, but the latest skilled product of the automobile art was not potential in the first crude machine. Every improvement has been a new creation. Suppose that you are building a new house and you describe how the plan has "evolved" in your mind. But the fact is that every change or every addition was a new thought, an improvement, a plus, a creation. The original simple house plan did not contain any potency of the final perfected scheme.

Briefly, then, the meaning of evolution is that it is a creative process, something new appearing at every step of the developmental history. Evolution is a process not of unrolling but of upbuilding. Every change is a transformation. The French word *transformisme* is a happier word than the English "evolution" or the German *Entwickelung*.

Evolution is a history of new forms and functions. Every new form is a plus—a new creation. Since Wundt introduced the notion of creative synthesis, the word *creation* is coming into general use both in science and philosophy. Creative evolution is a phrase made famous by Bergson. Professor Moore in his book, "The Origin and Nature of Life," says that "traces of evidences are lately beginning to come into view which are highly suggestive of continuous present-day creation of matter at the inorganic level, and of creation of life from inorganic materials at the organic level." Creation does not mean the production of something out of nothing. The architect creates a Gothic cathedral, but he does not create the stone and mortar. The promoter creates a new organization, but he does not create the men that compose it. Creation means just this—the production of something distinctly new and unique. Reality is found, as Aristotle told us long ago, in structure, form, organization and function, not in the mere stuff which happens to compose the material. Organic evolution is essentially constructive and creative.

IV

Out of all this there emerges a curious and unexpected convergence of the two supposedly irreconcilable theories of the evolutionist and the special creationist. An illustration will make this convergence clearer. It is repugnant to the special creationists to suppose that the mind of man has been evolved from animal behavior. But we see now that mind according to the evolutionists is not something evolved *out of* animal behavior. Mind is in no way potential in such behavior. When it comes it is something new. Even according to the obsolescent Darwinian theory of small variations, every variation is a novelty, and somewhere in the history of mental development an all-wise observer would be obliged to say, "This is no longer animal instinct, it is mind"; while according to the mutation theory, we may believe that mind more suddenly appeared.

Let us suppose, however, that the special creationist is not satisfied with this identification of the two views. He believes that God created man in his own image a little lower than the angels, while evolution teaches that man is descended from ape-like creatures by a natural process. The two views are thus, as he thinks, diametrically opposed. But are they opposed at all? A little careful reflection will show that they are very much alike, for whence, according to the theory of evolution, come those all-important variations, those wonderful and unexplained mutations, those significant increments and novelties? They just appear. But they do not appear without a cause and, as we have seen, they are not implicit in the first life germs. If, however, as evolutionists believe, they are upward steps in an epigenetic process, if they are new creations, some adequate creative power seems to be implied. As life and mind are the results of the organization of simple physical and mechanical units, some adequate organizing agency is required. Something or some one is mar-

shaling the units into a majestic order, call it, if you please, with Wells and Shaw, a life force; call it with Bergson an *élan vital;* call it an evolutionary urge, or struggle for existence, or will to live; or call it, as Lloyd Morgan does in his recent book on Emergent Evolution, just simply God.

Here, of course, the objection may be urged that the reconciliation is very incomplete, since the evolutionist often does not admit the existence of any life force, or *élan vital*, or any creative God, but attributes the whole evolutionary movement to the action of resident forces. Le Conte, for instance, defined evolution as continuous progressive change according to certain laws and by means of resident forces. But the fundamentalist might have no objection to this definition, for he, no doubt, believes in an *immanent* God, who "resides" in the world and exercises his creative power there; and the evolutionists, at least many twentieth century evolutionists, when they speak of resident forces do not use the word *force* in the sense which it bears in the mechanical sciences, for the latter is not cumulative, creative nor progressive. In like manner the old dispute as to whether the creative forces are natural or supernatural has lost its significance, since the meaning of the word *supernatural* depends wholly on the limitation which one chooses to put on the term *nature* or *natural.*

But what about the other part of the fundamentalist's creed, namely, that "man was created in the image of God, a little lower than the angels"? At first it seems as if there were a fearful contrast between this view and the doctrine that man is descended from ape-like creatures, but the contrast speedily disappears when we reflect that man by means of these successive increments has progressed so far away from the ape-like creatures that he is now only a little lower than the angels. According to the evolutionary theory of the present, it is a very long time that man has lived upon the earth, half a million years and perhaps much more. If one should go back farther than that remote time and inquire as to the form of the prehuman race, it could only be said that such a race was neither simian nor human. But the significant fact is that in that immense time man has climbed a long way toward the angels and seems indeed to be approaching the image of God. For we think of God as the power which makes for righteousness, the sum of ideal values. and slowly but surely, now with rapid steps, now slipping a little back, man is realizing those ideal values. He is never satisfied with the heights he has gained, but aspires upward. Human slavery, war, the subjection of woman, child labor, religious intolerance, intemperance—they were all once just taken for granted. Now we are ashamed of them all. Some are gone, all will have to go. Human interests are ever getting higher. Art, literature, science, philosophy, social service, social justice, more equal opportunities, rights of women, of children and of laborers—these are the enterprises of men of the twentieth century.

Another feature of twentieth century evolution is the lesser emphasis put upon the notion of nature as a battlefield—as a scene of sanguinary and ruthless struggle in which the fittest survive. This was one of the unhappy ideas associated with the name of Darwin, even until recently made the excuse and vindication of every evil thing in human society. It is unfortunate that a part of this precious twentieth century has got to be spent in "unthinking our convenient Darwinism." Professor Patten, writing as a biologist, says that the altruism and cooperation which we are coming to recognize as the absolutely indispensable condition of further social evolution are basal and primary factors in the grand strategy of evolution in nature itself.

In fact, there seem to be indications

that the whole evolutionary nomenclature of the nineteenth century was unfortunate. Perhaps we need a new set of terms all around to describe that great world movement which for seventy-five years has gone by the name of *evolution*. Many biologists are beginning to question the presupposition of the nineteenth century that the concepts of the mechanical sciences have any special prerogative in the interpretation of life and mind and society. Professor Haldane has gone so far as to reverse the order and suggests that "the idea of life is nearer to reality than the idea of matter and energy," and J. Arthur Thomson believes that the formulae of physics and chemistry are no longer adequate for the description of behavior or of development or of evolution. It is generally felt that Herbert Spencer "put something over" on the scientific world when he exalted a certain trio of concepts, namely, matter, motion and force, whose redistribution was to explain the whole world.

Biologists of the present time are largely engaged in patient and persistent investigation in the field of genetics, wisely refraining from speculation as to the causes and meaning of evolution. But it is difficult to refrain from all speculation, and when biologists do enter the field of philosophy and speak of theories of evolution, it is interesting to notice the new terms which they are using. We hear much of creative evolution, not always in the strict Bergsonian sense. We hear of "emergent evolution."[4] We hear evolution described as "a struggle for freedom,"[5] or as a process in "self-expression." We hear of animate nature as being the work of "an artist with inexhaustible imaginative resources, with extraordinary mastery of materials."[6] We hear of the material fabric of nature as being "alert" rather than "inert." We hear of "the grand strategy of evolution."[7] We even hear of evolution as a process of achievement, in which life and mind and moral conduct and social organization and science and art are values which have been won.

V

It should be noticed finally that the insufficiency of the terminology of evolution has been shown equally in other fields of inquiry than in the plant and animal kingdoms. When we hear of astral, geological, atomic and societal evolution, we wonder just what content the word carries in these several fields. Herbert Spencer, to be sure, devised a celebrated formula which he called evolution and which he thought he could spread like a net over the operations of nature in every phase of its activity. Evolution, he said, is "an integration of matter and concomitant dissipation of motion; during which the matter passes from an indefinite, incoherent homogeneity to a definite, coherent heterogeneity; and during which the retained motion undergoes a parallel transformation." In the last century this was considered a brilliant generalization, explaining the meaning of evolution. It is now considered a rather empty formula, significant and interesting, to be sure, and true in a way, but not so universal or significant as Spencer thought. Certainly it has no claim to being a law of nature, since one would hesitate to use it in predicting the future in any field of inquiry. With our fuller knowledge now, I think we should say of Spencer's formula—If it be true, what of it? We may call this evolution, but we are no wiser than before. Spencer's identification of evolution with progress, furthermore, no longer commands respect.

[4] Compare C. Lloyd Morgan, "Emergent Evolution," and J. Arthur Thomson, "Concerning Evolution," p. 205.

[5] By Albert P. Mathews in "The Road of Evolution," *Yale Review*, January, 1922.

[6] "The Outline of Science," Vol. iii, p. 705.

[7] Compare William Patten, "The Grand Strategy of Evolution."

What content has the word *evolution* as applied to society? Recent schools of sociologists place much less emphasis than formerly upon the concept of societal evolution, and when they use the word they mean usually nothing more than that society changes in a certain orderly manner. Society does not unroll, neither are its movements well described by Spencer's formula. Society changes, and as we look back upon these changes we can detect a certain "design," not of course in the sense of something designed, but of something in which a certain unity and meaning can be discerned. When, therefore, sociologists persist in speaking of social evolution, it is rather from the force of habit or the tyranny of nineteenth century thought than from any special appropriateness of the word. Society does not unroll nor evolve; it is changed, enlarged, and *sometimes* perfected by the successive additions of new ideas and institutions, such for instance as the cinema, the automobile, aerial transportation, votes for women, the League of Nations, limitation of armaments.

One hears again of mental evolution, but if from our modern point of view we examine the process by which mind has come into the world of living organisms, we find that the word evolution fits it poorly. There is no evidence, for instance, that those fundamental elements of mind which we call conative tendencies, wishes, impulses, those profound "energy influences seething and bubbling in the organism" *evolve* in any sense of the word. They seem rather like persisting appetites or cravings or aspirations seeking a goal. Neither does intelligence nor consciousness evolve. Instincts are not potential in tropisms nor is adaptive behavior potential in instinct, nor is intelligence a more complex form of instinct. Intelligence, when it comes, is something new—a new instrument, a novelty, perhaps an achievement. The mechanistic, Spencerian, Darwinian vocabulary of the nineteenth century does not fit the birth of mind, nor do the formulae of evolution illumine it. And then, of course, there are great spheres of reality where evolution is not present in any sense, such for instance as time and space and the laws of logic and mathematics and the laws of nature.

One hears also lately much about the evolution of matter. What does the word mean here? The discovery has been made that the atoms of certain elements of high atomic weight disintegrate into elements of lower atomic weight. The guess is ventured, therefore, that all the elements may be theoretically resolvable into a simple element, such as hydrogen, and the further guess is ventured that somewhere and sometime the reverse process may take place, so that from some simple element, such as hydrogen, all the other elements may arise, and presumably they will arise in the order of their atomic weight. To the latter process the name evolution has been applied. But it seems to be just the opposite of an evolutionary or unrolling process. It seems much more like a creative synthesis, an architectural enterprise. One looks instinctively for the architect.

In fact, not only in the creation of matter and in the birth of mind, but throughout the whole course of nature's expansion, the thought of the twentieth century seems to dwell on other aspects than those emphasized by Spencer and Darwin. Our interest is now centered more upon "formative forces," forces that are creative, cumulative and synthetic. "Organization" is a better word than "evolution." The new does not come from the old either by a process of unrolling or by a mere additive process. It appears to come as a result of organization. Even the word "organization" seems too tame as a description of Nature's efforts. As Stewart Ed-

ward White says in his recent book "Credo," nature seems to be the upsurging of a single vitality seeking outlet, and Bernard Shaw thinks that the saying, "Where there is a will there is a way" expresses more truly the meaning of evolution than the Darwinian selection theories.

In the eventful years which are to follow in this wonderful twentieth century, when the future of our civilization seems to be in the balance, the two things that are most needed are cooperation and creative effort. And strangely enough, the science of the day finds just these two things to be principles more original and significant than the chance variation and survival of the fittest which characterized nineteenth century thought.

There is no real reason to believe that the forces which are working towards progress in society to-day are essentially different from the forces which in the past have been productive of every new step in the development of plant and animal life or in the production of animal and human intelligence or of consciousness and moral judgment. The phrase "creative effort" designates these forces better than the term evolution. It remains for some one to discover a still apter term to characterize the world movement, a term which shall catch the ear of the twentieth century as evolution did in the century past. When this new term is discovered, evolutionists and fundamentalists may find some of their differences harmonized.

OVER-POPULATION AND THE LIVING-STANDARD

By Professor EZRA BOWEN
LAFAYETTE COLLEGE

A TINY colony of ants appears upon your hearth. A few grains of sugar somehow fell there and attracted these immigrants. There was food in the region from which they came, but it was not so plentiful as in this New World. Just so has America become peopled with Europeans.

An ant, let us say, requires for sustenance one grain of sugar a day; you supply, daily, exactly ten grains; the ant population will soon settle down to exactly ten. If there were originally thirteen ants, three must emigrate or die. There are just ten grains of sugar, and that will support ten ants—no more.[1] The rate of propagation is a furious one. That matters not. Ants in other regions get wind of the sugar, and a terrific immigration sets in. Again, no matter. Immigration, emigration, death-rates, even birth-rates, have nothing to do with population; or rather, they are secondary matters, themselves determined ultimately by economic considerations. The controlling fact is the sugar supply, ten grains; that settles it, a population of ten, yesterday, to-day, forever. . . . The population of Nevada per square mile amounts to seven tenths of a person; Nevada's meagerness will support no more. But Massachusetts' humming mill-wheels produce a flow of value that supports a population, per square mile, of four hundred and seventy-nine. More sugar, more ants.

In a burst of open-handedness, you raise the sugar ration to twenty grains. A few weeks later you take a census—and with what result? To be sure: twenty ants. There was immigration, but no matter; the death-rate slackened; even the birth-rate may have changed—we must ask the biologist about that—but no matter. There is but one matter of import: twenty grains of sugar, daily, instead of ten. Ten grains: ten ants. Twenty grains: twenty ants.

For hundreds of generations, the population of North America (before Columbus) remained nearly stationary at a million and a half: to-day, only four and a half centuries later, it is a hundred times as great. The vast wilderness for thousands of years yielded to bow and arrow sustenance enough for a million and a half of mankind—no more. Then forests were felled, making rich tillage and pasturage. Machinery came, and system, and science, opening richer fields: coal fields, oil fields, iron fields, copper fields, gold fields. A Niagara of value poured forth its abundance. Population increased a hundred-fold. More grains of sugar: more ants.

Let us see how our little colony is getting on: Twenty grains of sugar, daily, and twenty ants. . . . However absurd, let us say our ants demand some bird-shot to roll about in play. No; our generosity will not afford so much. But as they insist—especially two or three fat fellows that nibble some other's sugar grain when theirs is eaten—we

[1] This ant example is of course purely imaginary, a mechanical or artificial illustration. The physicist, exhibiting the model of an oxygen atom, is not trying to prove a theory of matter, but merely endeavoring to *illustrate* a strongly appealing hypothesis. In fact, this little essay is, in whole, simply an attempt to illustrate an hypothesis of population—a clearer and fuller statement of the author's "Sponge Theory of Population," published in the January 7, 1925, issue of *The New Republic*.

compromise on ten shot and, daily, ten grains of sugar. Ten grains of sugar and twenty ants? Yes; ten ants must die. A standard of living that includes both sustenance and play pinches out ten lives. High and unbalanced living-standards are as deadly as natural scarcities.

Had our ants been content with five shot for play and fifteen grains of sugar, the population could have been maintained at fifteen. Had they insisted upon their shot and other gimcracks besides, driving us to cut the ration to five sugar grains, the surviving ants would have lived a well-equipped, civilized, sophisticated life; but the survivors would number only five. . . . Our example is absurd?—it is not true to ant life? No; but true of man life, where interest is thus divided between desires and needs.

A wren, a mouse, a perch—all living things but man—have a fixed standard of living, a bellyful every so often, and nothing further. An increase in sustenance means a like increase in population. But man produces consciously a large part of the food values he consumes, and he insists upon producing and consuming other values as well. (The value of the motor-car that just flashed by —that value, in food, would support a workman's family for seven years.) Man's productive energy is divided; part is expended upon the production of food values, and part upon the production of far different values: buildings and clothes, steamships and railways, theaters and parks, telephones and motion pictures, radios and motor-cars, smoking materials and chewing gum. In the proportion that these things enter into the living standard by just so much, the tendency of human population to increase as wealth increases is thwarted. Populations, whether of ants or wolves or butterflies or men, tend to increase directly as weal increases; but when we speak particularly of man, we must add: population tends to decrease as the standard of living rises.

Though the flow of wealth in Great Britain more than equals that of China, the population of Great Britain is but forty million, and the population of China four hundred million. A vast difference in living standards explains this striking contrast: the Chinese standard of living is hardly a tenth as high as the British. The population of the United States is one hundred and ten million; the population of India triples that amount, though India's rate of wealth production is not a third that of the United States. Again, a difference in living standards will explain. If Americans were to convert into food the huge flow of value they create, contenting themselves with an East Indian standard of living, the population would soon number half a billion—assuming, of course, the necessary improvement in agriculture, or the production of synthetic foods; and neither of these assumptions is so bold as the suggestion that the American cut his standard to a tenth its present dizzy height.

Birth-rates, death-rates, immigration, emigration—all are secondary considerations in the population problem. The piston, piston-rod and crank-shaft of an engine are important, but secondary, circumstances; the underlying matter is the expansive force of steam. Controlling factors in the growth of human populations are but two: the rate of wealth production and the standard of living.

Insect, animal, reptile and plant populations vary directly as the means to existence increase or decrease. These creatures are not hampered by intelligence and a craving for ever higher living standards. But with man it is different: *As between areas in which similar standards of living prevail, population varies according to the amount of annually available wealth; in areas that produce equal amounts of wealth, popu-*

lation varies inversely with the height of living-standards.

The amount of value produced annually in Montana is about equalled in Mississippi: but Mississippi has three times Montana's population. Simply, the standard of living in the Southern black belt is very low. Standards of living, on the other hand, are about the same in Idaho and Kansas; yet Kansas' population is four times that of Idaho. And why? Kansas produces annually a far greater wealth than does Idaho. If the flow of value in Great Britain increases ten per cent., but every family consumes ten per cent. more, in comforts or in luxuries, population must remain the same.

One more principle must be included to cover fully the man case in population: Standards of living tend to increase more rapidly than wealth. Everyone sees this principle at work in his neighbor's conduct—some few admit its influence upon themselves. Give the brilliant young thirty-six-hundred-dollar-a-year assistant-cashier of a big city bank a vice-presidency, and how quickly his standard of living runs up to and exhausts his new twenty thousand dollars. The laborer, with his large family, has a milder craving for a high plane of material existence than has the foreman over him. The penniless negro has less concern over the growth of his family than has his well-to-do white neighbor; the mechanic minds less his increasing brood than does the rising young physician—his worried eye flitting from wife to calendar to bank-book. If standards of living increased proportionately with wealth, the tendency toward small families would be the same all down the line; but as you run the economic scale, you find, as wealth increases, the pressure toward restriction becoming ever greater—this, as true of nations as of families. For standards of living—or of craving—increase *more rapidly than* wealth. Wants increase as wealth increases, and this is generally recognized; but, quite as important and nowhere recognized, is the fact that this increase itself increases—there is acceleration. Here is a principle that goes far in explaining the large families of the poor, and why the tendency toward restriction works in the well-to-do family and in the prosperous nation with such devastating effect.

Populations of all kinds, animal and vegetable, tend to increase directly with abundance in the means of existence. With man, the consumer of varied and conflicting values, population tends to increase as the flow of value rises, but this tendency is offset to the extent that non-essential values enter into the rising living standard. We have no quarrel with modern standards of living; to the contrary, higher and higher standards are desirable, and as inevitable as they are good. An explanation of the principles of population is all that is here attempted. But if a moral must be pointed, it is this: The desirability of a good quality of food and other essentials is by its very obviousness thrust into some oubliette of consciousness; while luxuries, which are the more conspicuous for their scarcity, are feverishly desired. Until education has given every one a much sounder scale of values, some external influence must be set up to make the emphasis in the consumption of goods and services fall where it should.

The upward trend of living standards, almost entirely the result of an increasing insistence upon nonessentials, constantly outruns all gains in wealth. Presuming no change in man's scale of values, our net conclusion then must be: The enigmatic, decreasing increase, at present so conspicuously general to human populations, will continue—until of course, populations begin actually to shrink.

LESSONS FROM FIJI

By Professor C. C. NUTTING

UNIVERSITY OF IOWA

I

Our friends received the news that we were going to Fiji with cheerful predictions that we would meet our fate as interior decorations of the natives. This typifies the ordinary information that most Americans are conscious of regarding Fijians—that they are cannibals; and it is just about as up-to-date as a belief that Americans are given over to the practice of burning witches.

A hasty review of recent publications regarding the South Seas gives one the impression that few of us go there with the idea of learning anything that is of ethical importance or soul-elevating. Some go to exploit the simple savage in a commercial way, others to teach him to be good and civilized; and still others, and they reap a rich literary harvest, to expatiate on a paradise of lovely women in scant raiment and morals to match.

Our party of naturalists from the State University of Iowa had no such objectives. We hoped to learn a few worth-while things, and we did; indeed, we learned so much that was unexpected that we are garrulous about it. The natives themselves interested us most of all. The population of the Fiji group furnishes material for serious reflection, particularly to one who has the point of view of the professional biologist; a way of looking at things that is not evident in recent publications concerning the South Seas, but never the less well worth presentation and consideration. There are about ninety thousand Fijians proper, sixty-one thousand "Indians" or Hindus, as we would call them and forty-five hundred whites scattered through the two hundred islands, most of which are small and uninhabited. The total area is somewhat greater than that of the British West Indies, excluding Trinidad.

We found the Fijians as different from the other Polynesians to the eastward as the English are from the French. They are upstanding, soldierly fellows, not flabby, but with good hard muscles; men who looked the white man in the eye without either servility or truculence, men who dealt honestly with you and insisted on honest dealing in return. They are considerably darker than the other Polynesians that we saw, probably owing to a negroid admixture from New Guinea or New Hebrides, and seem to be more alert and virile than the natives of Rarotonga and Tahiti, for instance. Their chief personal adornment is their hair, in which some of them take inordinate pride. It is kinky, but not woolly, stands out for four or five inches all around the head like a black or reddish-black halo, and is clipped evenly as by a lawn-mower; really an imposing and stately head ornament.

One man, belonging to the Defense Force and sporting a particularly fine *coiffure*, explained that he washed his hair thoroughly three times a day, dried it carefully, rubbed in cocoanut oil and then combed it out straight. He slept with a stick of wood under his neck, so that the precious headdress should not touch the ground. This seems a lot of trouble, but these men evidently think it worth it and it costs nothing but time.

I doubt that history can show a greater or more rapid change for the better than has taken place in Fiji during the last two or three generations. The details of the life and customs of these people given in the narrative of the Wilkes

A MILITARY DANDY OF FIJI, INORDINATELY PROUD OF HIS HAIR.

Expedition near the middle of the last century are so revolting as to be scarcely credible. Constant wars, pillage, murder, massacres of whole communities, cannibalism and other atrocities too frightful for detailed description fill many chapters devoted to Viti Levu, the main island; and these conditions prevailed up to within the memory of men now living, one of whom I saw at Bau.

II

Compare the nightmare of the last century with the situation as we found it. A people kindly, courteous, law-abiding, with no experience with tribal war for many years; a people among whom a stranger can travel in security. As a proof of the absence of thievery, for instance, it is sufficient to cite the fact that the Fiji Club, where we were given quarters while in Suva, has its doors and windows perpetually open day and night, even when the lights are out and all hands are asleep. Yet not a thing was stolen and no one seemed to consider even the possibility of theft. I was told by Colonial Secretary Fell that a stranger could visit even the remotest parts of Viti Levu with perfect safety to life and property. The natives are uniformly hospitable, even in the jungles of the interior; although it may be somewhat embarrassing to have the entire population of a village insist on seeing one to bed!

No one can contrast the past with the present conditions in Fiji without seeking the cause of this amazing transformation, and any honest inquiry will show that two factors are in the main responsible. One of these is the work of the missions and the other the wise colonial policy of Great Britain.

RATU POPÉ, CHIEF OF BAU, GRANDSON OF THE LAST FIJI KING.

One of the most popular pastimes of travelers in the South Seas is "knocking the missionaries," a sport hugely enjoyed by the very men whose lives would be an exceedingly bad insurance risk were it not for the presence and teaching of these same missionaries. The colonial authorities, who presumably know what they are talking about, have little sympathy with this form of diversion; but, on the contrary, are warm in their appreciation of the results attained by the various missions, be they Wesleyan, Roman Catholic or of any other denomination.

On invitation I accompanied the superintendent of schools on a trip to inspect the Wesleyan Mission in charge of the Reverend Donald Lelean. It occupies a large tract of high rolling land overlooking the Rewa River. The Baker Memorial School is one of the best buildings we saw in Fiji, and the entire plant indicates thrift, industry and good management. The station has a population of about five hundred people, including Fijians, Indians and missionaries, together with their families; and they raise enough taro, yams, bananas and other vegetables to meet their entire needs. Here is the first kindergarten established in Fiji, and a manual training school where natives under the direction of skilled mechanics make furniture and other things, some of them under contract with the government. Their grandfathers were cannibals during the bloody régime of Cacobau, the last of the Fiji kings and grandfather of my host, Ratu Popé of Bau.

Our investigation of the situation in Fiji gives us the feeling that knocking the missionaries would be just about as zestful an amusement as abusing the lassies of the Salvation Army; and I confess to a suspicion that some recent trav-

A FIJIAN COSTUME, NOT OF FIG LEAVES.

elers to the South Seas feel a personal resentment against the missionaries for their activity in blocking the unrestrained enjoyment of the unmoral condition of the childlike natives.

It is hard to resist the further impression that there is a similar background for the indignation aroused by the insistence on the part of the missionaries that the natives wear at least a decent minimum of clothes.

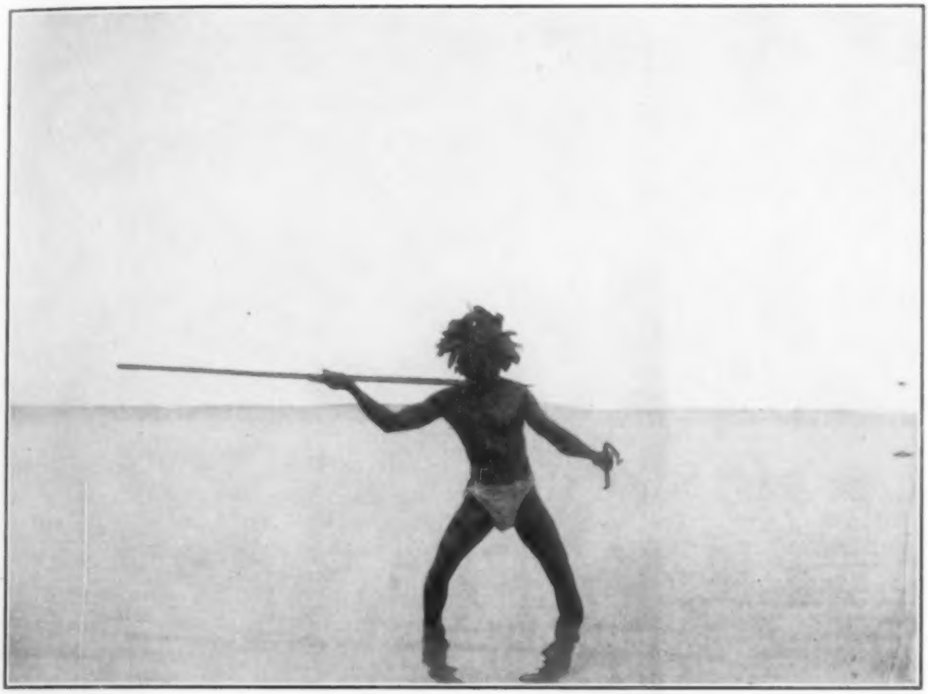
III

Speaking of the Baker Memorial School reminds me of another and very practical lesson. After leaving Fiji we were told the story of the killing of the Reverend Mr. Baker, in whose honor the school was built.

It seems that a Fijian chief visited Mr. Baker and, seeing a comb which took his fancy, appropriated it and stuck it in his bushy hair. The missionary, perhaps without due reflection, reached out his hand, removed the comb from the chief's head and was immediately killed by his followers—a most atrocious and unprovoked murder according to our ideas. But let us look at it from the standpoint of the natives.

According to their laws the chief had a perfect right to appropriate anything found in his territory. Moreover, his person was sacred from profane touch, particularly his *head;* and the violation of this tabu was inexorably punished by death according to all the long-established and recognized customs of the land. Imagine an American woman violated in the presence of her people, and we have a situation which seems to be parallel. In the eyes of the Fijians the killing of Mr. Baker was a justifiable legal execution, not a murder at all!

One of the most revolting customs of the natives of Viti Levu, as related by Wilkes, was the murder of parents by their own children, a universal custom



THEY LIKE TO ADORN THEIR HEADS WITH LEAVES.

according to his narrative. Now let us take their point of view.

The old Fijians believed in a real physical immortality. They believed, moreover, that a man lived throughout eternity in the physical condition in which he died. If aged and infirm at death, he would forever be infirm, perhaps helpless. Therefore the Fijians feared old age with its accompanying disability much more than they feared death. Hence they requested, even demanded, that their children perform the sacred filial duty of putting them out of the way. According to their tradition, law if you please, the sons were not only justified but required to perform an act which we regard as one of the most horrible of all crimes.

IV

Here we learned the lesson of the simple life, expatiated on by most writers on South Sea experiences. The details are worth our pondering, and will be of use later on. The cost of living is here reduced to a minimum and this reduction of cost means a corresponding reduction in necessary labor. The family budget is not formidable and would be something like this:

For clothing, practically nothing, as neither men, women nor children wear anything on head or feet, and Easter bonnets are unknown. The men ordinarily are clothed simply with the "sulu," a piece of cotton cloth about the size of an ordinary face towel wrapped about the loins and rolled in at the waist to hold it in place. The children dispense with even this: while the good wife wears an everyday costume consisting of a sulu of somewhat ampler proportion. But on Sunday she wears a cotton "mother Hubbard" without tucks, flounces or other extravagances.

OFFICIAL SERVERS OF KAVA AT BAU. NOTE THE HIGH-BRED FACES.

THREE BAU BELLES.

Sometimes she wears under this a tapa skirt of her own weaving. There are no millinery or dressmaking bills whatever.

For the family domicile, next to nothing. The poles for the frame are selected from the adjacent forest, and reeds fastened together in neat patterns with sennet form the inner walls of the one-room house. The roof is of thatch and the outer wall is formed of imbricating leaves to shed the rain. A single opening serves as door and window, while the floor of hard earth is elevated a foot or two above the ground and covered often with tapa mats, made at home by the women. No glass, no nails, no hardware of any sort; and no labor unions have to be dealt with, neither is there any walking delegate to make afraid!

For furniture, a few shillings to purchase a porcelain plate about two feet in diameter, in which the family meal is served; or perhaps it would be better to call it a *community* meal, cooked on the common fire out-of-doors. There are no beds nor bed-linen, fine mats of tapa cloth serving the purpose; no tables, chairs, knives, forks or spoons. Cups are made of gourds, bowls of calabashes and no individual plates are used; neither are there carpets, wallpaper, stoves or books. Of course there are no beds to make, carpets or rugs to sweep, dishes to wash or tables to set. Think of that, girls, and the women's lives are without the daily grind of endless drudgery so nerve-wearing in the case of the middle and lower classes in America.

FIJIAN STUDENTS AT THE WESLEYAN MISSION.

For food, a few pennies per week for extra luxuries not produced locally. A little patch of ground is sufficient to meet the family needs in the way of taro, yams, plantain and other vegetables; while breadfruit, mango, oranges,

A TYPICAL FIJI VILLAGE IN THE INTERIOR. (*Photo by A. O. Thomas.*)

THE OLDEST INHABITANT OF BAU AND THE "CORONATION STONE" OF FIJI KINGS.

sometimes pineapples and always cocoanuts in abundance are near most of the villages. Little meat is required, although much relished; a pig or two, perhaps a goat and a small flock of chickens are raised by the villagers themselves. Fish are plentiful near the coast and along the main streams, and the Fijians are skilful in the use of spear, fishtraps and nets. For drink, the kava made from the yangona root is universal throughout the southern Pacific. We found no evidence that it is intoxicating, although its use is confined to the men.

THE FIJIANS CAN WORK, AND WORK HARD, ON "STEAMER DAY."

V

These people seem content and appear to be well nourished. They live mostly out-of-doors and have enough exercise to keep them in good physical condition.

Their pleasures are simple, but apparently adequate. They sing a good deal and sing well. Occasionally they indulge in a "*meke*" or dance, but we did not see men and women dancing together. They talk, often vociferously, and enjoy it. Kava drinking is a sort of social ceremonial, and sometimes lasts nearly all night. The women are modest in bearing and seldom show sex consciousness, in which they differ from most Polynesians. For all that we could see there is little laxity in morals, and little evidence of mixture of races. The Fijians dislike the "Indians" and want little to do with them, and the whites find hardly any lure in the native women. Each race lives its own life in its own way and seems satisfied to do so.

The British officials respect and like the Fijians, who are by no means inferior intellectually. I met one barelegged and bushy-haired fellow who is an Oxford graduate, fought in the For-

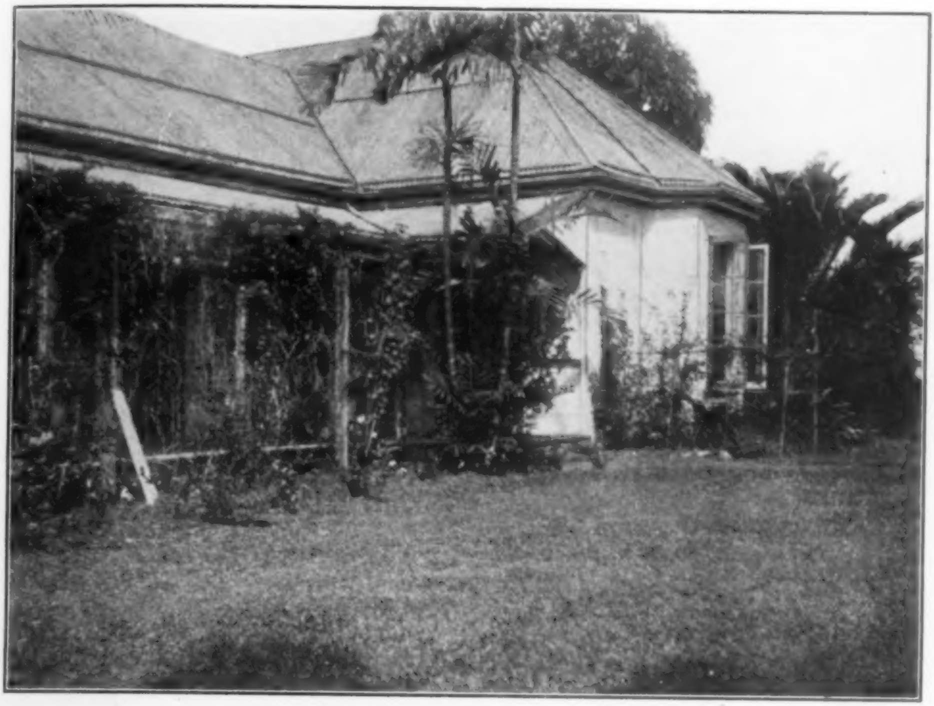
THEY ARE SKILLFUL MAKERS OF FISH NETS.

eign Legion in France, and is a scholar and a gentleman. Another, Ratu Popé Chief of Bau, showed an exquisite courtesy when I was a guest in his home, spoke as good English as any of our party, is a member of the executive council of Fiji and showed a good knowledge of world affairs. Nor am I alone in finding much to admire and something to envy in the simple life of primitive folk. Nansen and Stefansson express the same sentiment regarding the Eskimos, and O'Brien grows eloquent in describing conditions in Polynesia. In Captain Monkton's "Last Days in New Guinea" are many photographs of natives closely resembling the Fijians, even to the bushy hair. He describes one of the largest tribes, the Binandere, as a people who "though fierce, warlike cannibals were also honest, truthful, and moral to the last degree."

The contrast between the daily life of the Fijians, when removed from the Europeanized cities, and our own is as striking as can be imagined. They are the extremes of simplicity and complexity and the difference is worldwide. Is there a corresponding difference in happiness? They know nothing of the delights of the opera, nor of art in any form. Regarding their behavior Major Chapple says:

> Nothing is ever seen to offend the most sensitive observer. There are not even overtures of affection between the sexes. The women are shy and diffident. The men never leer or follow. The Fijian people might be all of one sex for all that in public is ever betrayed. Hyde Park or Brighton Beach would shock them to stupefaction. The promiscuous love scenes portrayed in the pictures reveal the whites in an unfavorable light to the astonished Indians and Fijians.

All this is so absolutely different from the stories brought back from the South



THE DOORS AND WINDOWS OF THE "FIJI CLUB" ARE PERPETUALLY OPEN.

Pacific by our popular writers that it is worthy of our serious contemplation. The writer is not here challenging the truth of these charming descriptions; but does insist that it is *not* true of the Fijians!

To return to the discussion of the contrast between simple and complex civilizations: It may be conceded that we have an immeasurably greater variety of enjoyments than they, more thrills, if you please; but do we not also have an almost infinitely greater number of annoyances, anxieties, nerve-wrecking stresses and strains—to say nothing of actual want and grinding poverty? Taking it "by and large," are we happier or more unhappy than the Fijians? The answer is, of course, "Both."

Nearly all Fijians live in small villages scattered throughout the islands, and each village is a typical commune in itself, thus affording an excellent opportunity to study the nature and results of communism in its simplest expression. When the biologist wants to unravel the mysteries of the living organism he finds it profitable to focus attention on the simplest of beings which manifest the properties of that marvelous complex which we call "life." The study of the Amoeba, for instance, has given us some sort of understanding of all the fundamental properties of protoplasm, which has been called the "physical basis of life," properties which are believed to hold throughout the whole range of living things from the Amœba to man himself. It seems evident that an examination of the communes in Fiji will enable us to understand the basic properties and natural results of the system in its more complex manifestations.

A recent writer says:

There is no ownership in Fiji, no individual ownership. All things are held in common, ex-

THE HOUSE OF RATU POPÉ, GRANDSON OF THE LAST KING OF FIJI.

cept the women—they are particular about that. If a thing is indivisible it is in the possession for the time being of the one who casually remarks, "That's a nice hatchét," or "That's a nice saddle," or "That's nice yangona."

I imagine, however, that if one man attains an object in this way another could relieve him of it by the same procedure and that there is a sort of *laissez-faire* sentiment by which is conceded practical possession of desired things by common consent. But the tenure is insecure, at best, and may be terminated by any one who cares to invoke the communal law. It appears, moreover, that a chief is exempt or superior to the law and can secure permanent possession of any coveted object that is temporarily the property of one of his people, and against this there is no appeal.

The perfectly natural result of the communistic idea is a lack of incentive to accumulate property. "What's the use," is the native's answer to such suggestion. "It wouldn't be mine if I did make it or pay money for it to some Indian." This appears to be the real reason for the reputation for laziness which these natives have among the whites. They can and will work, and work hard, as is demonstrated every "steamer day" by numerous husky Fijians, for a few shillings which they may spend on themselves or their families; but I doubt if the money is put into permanent investments of any sort.

This is, I believe, a valid objection to communism the world over. It offers no reward to individual initiative, no incentive to thrift, nothing to make it worth while to work steadily or more efficiently or embark in any enterprise that would result in added comfort or bettering one's condition.

THEIR FISH POTS AND OUTRIGGER CANOES ARE OF GOOD WORKMANSHIP.

The biologist knows that all advance in the organic world is due to the struggle for existence, or *competition*, if you please. It is the universal law of progress and applies to human affairs just as inexorably as to lower forms of life.

But there is another and more serious aspect of the case. Many Hindus, or "Indians," as they are called there, have been imported as plantation laborers and servants. For ages these people have lived in a densely populated country where the struggle has been most intense. They are industrious and thrifty and many of them have acquired property in the shape of little parcels of land and small shops of various sorts. Some of them seem well-to-do, even rich. The relations between Fijians and Indians are not cordial, to say the least. The Fijian regards himself as a better man than the Indian, dislikes him intensely and wants nothing to do with him; while the Indian has a contempt for the native and regards him as an inferior in business matters, a lazy good-for-nothing who is unable to get on in the world.

This situation between the main elements in the population is curiously like that existing in bird life in and around Honolulu. The pestiferous English sparrow from America and the ubiquitous "mina bird" from the Orient have practically driven the native birds from Honolulu and vicinity. An exactly similar situation exists regarding the human population. The Europeans from the Occident and the Chinese and Japanese from the Orient have invaded the country and the native Hawaiian race seems doomed to extinction.

THE BAKER MEMORIAL SCHOOL WAS ONE OF THE BEST BUILDINGS THAT WE SAW.

It is even so in Fiji. The British colonials on the one hand and the Indians on the other are the upper and nether millstones between which the really fine native race seems destined either to assimilation, which seems unlikely; or obliteration, which I sadly fear is probable.

The lesson, then, is that communism, although an alluring ideal, is but an iridescent dream doomed by an inexorable natural law to failure when brought into competition with a people inured to the struggle for existence by which progress is alone possible from the biological point of view.

PERSONNEL, PERSONALITIES AND RESEARCH

By Dr. CARLETON R. BALL

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For many years the writer has been concerned with the administration of research projects. During this period the conviction has been growing that, of the several factors contributing to effective research, the importance of the personnel factor has been underestimated. This seemed to be especially true of that phase of the personnel problem which may be designated as personality. The present paper is devoted to a discussion of that subject.

Research is the order of the day. The last few years have produced a flood of papers dealing with one or another of its phases or relations. The word research itself seems likely to become one of those overworked terms, a sort of shibboleth like psychology, reaction, complex and others that will come readily to mind. Without stopping here to define the term, it must be noted that not all quests for facts are to be called research. They may be mere observations, they may be surveys. Even where the experimental method is used, it does not follow that the process can be called research. It is better to separate these processes into three classes, which, in the ascending order of their difficulty, may be called experimentation, investigation and research, respectively. No hard-and-fast line can be drawn between them. They differ in degree rather than in kind. At the same time, some such difference must be recognized if we are to be honest with ourselves and our problems.

There are four chief factors concerned in every piece of research. These are (1) the problem, (2) the personnel, (3) the plan and (4) the equipment. Of these, the personnel is the most important. The problem changes as the research progresses, widening here, narrowing there, changing direction entirely from time to time with new developments. The plan necessarily changes somewhat with these shifts in the problem itself, and also with major changes in personnel or equipment. The equipment, including funds, space and apparatus, always is a variable. Much can be done with little of it; little may be done with much. Personnel is more likely to be relatively permanent, especially under any system of civil service appointment and tenure.

Varying Characteristics of Personnel

Personnel is the aggregate of all workers in an organization or attached to a project unit. The individual worker is a personality.

Certain attributes or characteristics are desirable in the research personnel. These may be grouped roughly under the two heads of training and ability. The latter is a complex. It comprises, among other things, imagination, initiative, resourcefulness, energy, persistence, judgment, honesty, accuracy, dependability, inspirativeness, loyalty and cooperativeness. If the meanings and relationships of these characteristics are studied they will be seen to fall into four groups.

Imagination, initiative and resourcefulness form the first group. They are the measures of the worker's ability to plan and to do or to interpret new things, or his ability to do or to inter-

pret old things in new and better ways. Energy, persistence and judgment form the second group. They are the measures of ability to overcome obstacles and to carry forward a piece of work steadily to its conclusion. Honesty, accuracy and dependability form the third group and, in a way, are the measure of the worker's ethical attitude toward himself in relation to his problem. The honesty mentioned here is a mental trait. Inspirativeness, loyalty and cooperativeness comprise the fourth group and are the measures of the worker's attitude toward his associates, his organization and his constituency. It is obvious that not all workers possess all these characteristics and that no two workers are likely to possess any of them in exactly the same degree.

The first and second groups are most nearly questions of ability. They are matters of the mind. The third and fourth groups are distinctly ethical in nature. They are matters of will. We recognize this dual grouping when we say one is both able and willing. One may be able but not willing, another willing but not able.

In the list of desirable characteristics discussed above, there are twelve separate items. More could have been recognized. Fewer perhaps would have served the purpose equally well. Mathematicians say there are 4,096 possible combinations of a group of characteristics varying in number from one to twelve. This suggests an amazing diversity in personalities. One person may present any one of 4,096 diverse expressions of personality, depending on the presence or absence of these attributes.

But this is not all the story. No characteristic is wholly lacking. Each one may vary in intensity, however, from near zero to the *n*th power. Multiply the 4,096 possible combinations by the possible different degrees of intensity of each one of these twelve characteristics. The possible variations run immediately to infinity and beyond. It is outside the power of the human mind to conceive this infinite variability in the human component of our equipment for research. The psalmist speaks of playing on an instrument of ten strings. We are asked to make harmony on an instrument of ten thousand strings.

Nor is this yet the entire story. A personality ordinarily is considered as virtually unvarying, the same yesterday, to-day and next year. But no! Temperaments may change their expressions from day to day, and even from hour to hour. Often there is no external sign of the existing reaction. If only humans would indicate states of feeling by chameleon colors. If only red and white traffic flashes warned us when to "stop" and "go" in making human contacts, the problem would be vastly simpler.

It is with this infinite variety of human ideas and consequent emotions and reactions that each worker must associate. It is this assembly of infinite variabilities that every administrator must attempt to evaluate, coordinate and stimulate. The task, of course, is impossible of complete accomplishment, but the motto of the researcher and the research administrator must be: "We specialize in the impossible." Ask any administrator of human activity which one of the four factors, problem, personnel, plan or equipment, requires the most thought and causes the most worry. Nine out of ten will confess that it is the personnel, if they are both thoughtful and candid. Brooks,[1] in his comprehensive discussion of "The Scientist in the Federal Service," analyzes the problem thus:

> Every administrator of research finds his chief problem in the control of his scientific

[1] Brooks, Alfred H. "The Scientist in the Federal Service." *Journal* of the Washington Academy of Sciences, 12: 73–115, Feb. 19, 1922.

personnel. To some this problem appears most simple and involves only the giving of financial support to the master mind and then allowing it to wander whither at will. Such a course, however, will not lead to the solution of a cooperative problem. Moreover, the master mind, if left to its own devices, may wander entirely off the premises. The task of the executive is to harmonize the work of a group of strongly individualistic investigators, whose tendency is centrifugal rather than centripetal. Success will be achieved by a proper balance between individualistic and cooperative inquiry. There is the danger, on the one hand, of discouraging originality of thought, and on the other, of failing to maintain the necessary unity of purpose.

The executive in the Federal scientific service stands between the horns of a dilemma. If his bureau is not so organized as to provide very definite control of the work of the individual investigator he may fail to achieve the results demanded by the terms of his grants. If his organization is such that it does not give full play to constructive thought by the individual investigator he will accomplish little to advance his science. He must constantly strive to have his administrative machinery sufficiently elastic to develop the best mental work possible by each of his scientific staff. At the same time he must not ignore his obligation to give results to the public.

It is a condition and not a theory that confronts us. We can not pass the buck if we would. Therein we are not so fortunate as Sambo and Mose. You will recall the heated discussion some years ago as to whether a fund given for general education by the head of a great corporation was tainted money or not. These two darkies were discussing that question. Said Sambo, "Mose, does you all reckon dat money am tainted?" Said Mose, "Shuah. Dat money am tainted twice. 'Taint yours and 'taint mine." The personnel problem is both yours and mine. To each worker, of whatever rank, it is a personal problem. To each administrator, of whatever rank, it is a personnel problem. Both are in honor bound to face it squarely.

Individualism and Organization

Do you wonder where this discussion is leading? Straight for the mooted question of individuality versus organization. How far is personality or the right of the individual sacred as against the right and the need of the community and the organization? The question will be discussed only in principle here. We are concerned primarily with personnel in this discussion. When it finally is answered the millennium will have come.

Paul, the great apostle, said long ago, "Bear ye one another's burdens," and immediately thereafter declared "For every man shall bear his own burden." That still is a good rule for human relations. It means, I think, that while a man must look out for himself he also has an equal duty to the organization. It doesn't seem to leave much room for the extreme individualist. I heard an eminent member of the Congress say recently, in a public address to farmers at Purdue University, that one of the things the farmer must be willing to give up, to insure the success of the new cooperative movements, was "his inalienable right to do as he damned please." This is a viewpoint by no means peculiar to farmers. It has been one of the long-cherished rights of the whole human race.

In early society the individual or the immediate family was the unit, and each did that which was right in his own eyes without regard to the welfare of other families. In the process of social evolution, the families became tribes and the tribes eventually became nations. During this process individual rights diminished and family rights increased, family rights diminished and tribal rights increased and, finally, tribal rights diminished and national rights increased. The civilized world is now in this stage of social evolution. There are many who think and pray that it is at the threshold of the next stage in this evolution where national rights will be less selfishly emphasized and international rights in-

creased. In other words, the unit of welfare has progressed from the individual and the family successively to the tribe and the nation, and now to the world of nations. Such an evolution has been taking place in our ideas of research.

Personalities are animate ideas. Ideas are the beginnings of progress. It is almost inevitable, therefore, that the beginnings of movements, institutions and organizations will be around a personality permeated by the idea involved. Striking examples of this fact have been brought out by others before me. Some one has said that every great idea was once a private opinion (the property of a single mind) and that only when it has become private opinion again (that is, the belief of the multitude) is it established. By their energy, single-mindedness and persistence to the point of self-sacrifice these strong personalities propound the idea and launch the institution or movement which carries it forward. This has been as true in scientific research as in invention, exploration, education, social reform, political emancipation or religious progress. Such development has been not only inevitable, but perhaps necessary and desirable in the formative period.

Historically, great new developments in science have been the result of individual research, discovery and invention, rather than the results of coordinated, organized, cooperative efforts. Because of the administrative dominance of strong personalities in the beginnings of research, there grew up an idea that research could be conducted only by individuals of great talent, isolated from other workers to avoid distraction and left without any administrative supervision or direction. The individualistic is the pioneer stage. Like the pioneer stage in other enterprises, it probably must be regarded as temporary, though there always will be and always should be pioneer spirits in every time and place. But for every far-reaching fundamental conception of a brilliant genius there must be hundreds of less revolutionary but equally necessary researches. Often these are complex in their ramifications and not well adapted to individualistic attack.

In studying the organization of research units or institutions two general classes are found. In one class the division or department of the institution is organized around a personality or personalities. In the other class the division or department is organized on the basis of logical and effective projects, with a coordinated personnel devoted to getting project results. These two general classes of organization are found whether we consider teaching, research or extension in our institutions of agriculture, or the varied activities of commercial agricultural organizations. Oftentimes these two classes are successive stages in the development of the same project or organization. Organization as such, whether on a personality basis or on a project basis, will be considered in a second paper. For the present we are concerned with personnel and personalities.

Defects of Organization around Personalities

A strong individuality frequently is an accompaniment of true genius, though not necessarily a proof of genius. Organization around a personality rather than around a project multiplies any defects of the dominant personality. We have noted that personalities having dominating qualities are likely to be narrowly specialized and oftentimes are extremely self-centered. Some of the defects of an organization based on such personalities are: (1) Inadequate view of the problem; (2) limited service to the supporting constituency, (3) injus-

tice to associates, and (4) perpetuation of the incompetent.

(1) *Inadequate View of the Problem*

As a project or movement develops, it becomes more complex and inclusive. The need becomes pressing for a broad survey of collateral facts, with possible readjustment of viewpoint and emphasis. Great personalities usually are men of a single idea which often becomes almost an obsession. Frequently they are unable to see the ramifying phases of the problem and its contacts with and obligations to other ideas, institutions or movements. This attitude makes for a narrow though perhaps brilliant development and not for a broad and comprehensive progress. A struggle to maintain the personal prestige may overshadow the obligation either to science or to a supporting public. No farmer having 40 acres would strike a back furrow on each 10-acre portion, plow a few furrows on either side of the back furrows and claim that his land was plowed. But such personalities come to regard their narrow strip as the whole plowland. In scientific institutions this narrow specialization of administrative leaders results in a similar condition. One line is greatly over-emphasized. Others, coordinate or subordinate, are largely neglected.

We have had the recent example of a state experiment station, in a large and wealthy state, in which the department of farm crops and soils was headed and dominated by a strong personality of this kind. Himself a soil chemist, he built up the soil section and neglected the plant section. He became internationally known and honored. His ideas of soil fertility became the center of inspiration as well as of both dogma and controversy. In the meantime he, and those associated with him, largely lost sight of other possible interpretations of soil phenomena and of the need for research on the plant as well as on the soil substrate. They carried this idea so far as to prevent the manning of their station for botanical and pathological investigation of crop plants. They neglected lines of development which comparable institutions considered important and imperative. Their staff members and graduates went out to other institutions imbued with these same narrow ideas.

When this great personality passed on it left a narrow organization unable to cope with some of the pressing agricultural problems which were present. When a crop disease broke out not long after, within the borders of this state, it became necessary to call on the federal government for help. There was no personnel or equipment within the state to deal with the problem. Reorganization has taken place, but fifteen or twenty years of valuable time have been lost because of a dominating personality with a too narrow specialization.

(2) *Limited Service to the Supporting Constituency*

Another tragedy of the narrow view is the withholding of service from the many who need. One of the oft-quoted sayings in education is that Mark Hopkins on one end of a log, and a student on the other, constitutes a university. So it does for the one student on the other end of the log, but what of the hundred other students? Is there to be no university for them? Mark Hopkinses do not occur by the hundreds. So too in the research field there is obligation to give the best and the fullest, even if it requires contact and cooperation with others. It may mean the giving up of a gratifying isolation. It was done gladly in the patriotic fervor of the war. It must be done at the less thrilling but equally challenging behests of peace-time

progress. A person of outstanding ability, but without the spirit of broad service, and the will to organize for it, is less valuable in the long run than one of lesser ability but with a broader view.

(3) *Injustice to Associates*

Sometimes dominating personalities become obsessed with their own importance. They lose the sense of comparative values of individuals. Some refuse to acquire associates who approach or equal them in rank or salary lest their own position suffer by comparison. Some will not have associates whose abilities and achievements seem in any way likely to equal or exceed their own and thus detract from their eminence. No more shortsighted and indefensible viewpoint can be imagined, especially where public funds and constituencies are involved. The result is a premium on mediocrity, or else a stifling discouragement of initiative and ability.

A related condition is that where a superior appropriates for publication, under his own name, all the material produced by his subordinates. The young worker is only a serf. Others do not go this far, but insist that their names shall appear as senior author of all such publications. Such arbitrary and unjust treatment quickly discourages the able and aspiring. On the other hand, harm may be done to young investigators by allowing them too much credit for work conducted jointly.

A corollary to the selfish attitude or character is the desire for flattery rather than the truth. This results in the evaluating of associates and subordinates by their good words rather than by their good deeds, a condition most repugnant to the self-respecting. To be obliged to associate with a toady is humiliating, but to see one in power and favor through such means is quickly destructive of morale.

(4) *Perpetuation of the Incompetent*

Another tragedy of the individualistic type of organization is that it permits the lazy, the selfish, the incapable and the obstructive to remain in positions of authority and influence. One day I sat at the desk of a fairly well-known scientist when his mail was delivered. He ran through a sheaf of letters and dropped about one half of them into the wastebasket as he glanced them through, remarking that he could not waste his time answering farmers' letters. He is now the chief teacher of his subject in another institution, but his department is turning out few able graduates. Another man of different outlook has charge of the investigations in that subject in the same institution and its research is well and favorably known.

I have in mind another institution. It has a division with two coordinate sections. The division chief is also leader of one section. In his section are five men with the doctorate degree. Nearly all are favorably, and some internationally, known for their researches. Its graduates are sought for. In the other section, equally large, there are no men with doctorates. It is not the fault of the division chief. This section is headed by a man who does not believe strongly in advanced study or in research. This standard is reflected throughout his section. Its staff members are but little known in the research field. Its graduates do not rank high. The leader of the crop section is a unique personality, widely known, but in his section an inhibitor rather than an inspirer of progress.

How long should such conditions be permitted to continue? When does the right of the individual to hold a job give way to the superior right of the institution to demand service and the constituency to receive it? The writer is not a prophet, nor the son of a prophet, but

he believes that institutional standards presently will rise above such levels.

There is another type of individualist not infrequent. He prefers the shadow to the substance. Perhaps the simile is not well chosen. Perhaps he prefers the sunlight to the shadow. At any rate, he is a better scientist in the smoking-room and the hotel lobby than in the field. He is more in evidence as an officer of scientific societies than as a publisher of scientific papers. He is not necessarily lazy, but he prefers the limelight to the laboratory. He is too good a cooperator. He has ideas, time and energy at the service of every organization except his own. He is the delight of the president who wants committee work done, but the despair of the administrator who wants research results produced. Then, to crown injury with insult, brother scientists tell his chief what a wonderfully brilliant, energetic and capable scientist he is, because they see him in effective action everywhere except in the project where he primarily belongs. He is in marked contrast to the many able workers who contribute freely of time and effort to scientific societies and still maintain a high output of project results.

Finally there is the obstructionist. He is instantly and vigorously antagonistic to any idea not his own. Obviously he can not achieve a very important position. He should lose the little he has. He is not taught by experience. He should beware or he is likely to meet the fate of the man who ate too much catsup. A small boy told me the tragic tale. The man was very fond of catsup. He ate it in huge quantities at every meal. Pretty soon one of his arms dropped off. He still ate catsup and pretty soon the other arm dropped off. Then one leg dropped off, but he still ate catsup. Finally, the other leg dropped off. Then he thought he'd better call a doctor. The doctor came and looked him over and said "You'd better look out. If you don't stop eating so much catsup something is likely to happen to you." The obstructionist is by way of being shorn of some of his powers for harm and if he doesn't look out something real is likely to happen to him.

Other Undesirable Individualities

Besides those discussed, there are many other types which present difficult problems for the administrator and for associated workers. Those illustrated below are by no means all that may be found, but they are among the more common.

The Jealous Worker

There is the jealous, suspicious worker. He is haunted by the thought that some one may receive more recognition than he, or some tribute that should have been his. He is certain that he is being discriminated against. He resents inspection of his data, and sidesteps discussion of his problem. He is angered by any success won by another. In its meanest aspect, such a character looks up his records and resents any administrative attempt to use his data in public service when he is temporarily absent.

Whetzel[2] pictures the attitude of such a worker. "One says, 'This is my idea. How shall I be protected in my possession and exploitation of it?' " Mees[3] says "The cell system (of individualistic research) tends to exaggerate the vices of such men. They tend to become secretive, to refuse cooperation, to be even resentful if their work is inquired into, * * *" As Mees points out also, it is difficult for any one else to take up the work of one of these secretive men in case of his death or resignation. For this reason, much of the investment in him may be lost.

[2] Whetzel, H. H. "Democratic Coordination of Scientific Efforts." *Science*, N. S. 50: 51–55, July 18, 1919.

[3] Mees, C. E. K. "Planning a Research Laboratory for an Industry." The Scientific Monthly, 7: 54–67, fig. 1, July, 1918.

The Narrow, Prejudiced Worker

There is another sort of scientist who has had broad training and should have broad vision but who instead is narrow and prejudiced on one or more points. It may be an unimportant matter, like dress styles or jazz or some rule of grammar or black cats, which is his pet antipathy. It may be a fundamentum of human relations or human knowledge, such as foreigners or Negroes or medical treatment or even evolution, against which he hurls all the weight of his power of reputation and personality. Because the things said by one carry much more weight than the things left unsaid by hundreds, this man of extreme prejudices has influence out of all proportion to his numbers. He leads the man in the street to dub all scientists as cranks.

Professor Kimball Young[4] tells of a professor of highest scholastic attainment with a graduating thesis so outstanding, in a subject akin to philosophy, as to receive prompt translation into French and German, and yet who was essentially a fundamentalist in his attitude toward biological science. The incompatibility of science and prejudice is well brought out by Millikan.[5]

> Man himself is just now emerging from the jungle. It was only a few hundred years ago that he began to try to use the experimental and the objective method, to try to set aside all his prejudices and his preconceptions, to suspend his judgment until he had all the facts before him, to spare no pains to first see all sides of the situation and then to let his reason and his intelligence, instead of his passion and his prejudice, control his decisions. That is called the scientific method.

The Brusque, Repellent Worker

Some persons have an almost brusque and forbidding way of talking and acting. At times it seems almost discourteous. Usually it is unintentional. Always it is antagonizing and repellent. How quickly we notice that sort of a manner at the other end of a telephone. The word we hear is "Hello," but the tone and manner say "What in thunder do you want when I'm busy!" If the person calling is a stranger, his opinion of the person or organization being called will be colored and perhaps fixed by these first impressions. When at the University of California recently, the writer was struck by the importance the university administrators placed on this matter of courteous contacts. In a little booklet[6] entitled "Suggestions for University Employees" occur the following pertinent sentences:

> Those employees who meet the students, the alumni, or the public have the greatest opportunity to communicate to the state at large the spirit of the University. * * * Be courteous and tactful. If the answer to a question of a stud nt or other inquirer is likely to be a disappointment to him, explain the reason for the answer and, where possible, state briefly the means to be employed by him in meeting the situation. Remember that the University does not grant all requests, but that it does attempt to be just. * * * Few qualities of service have greater value than alertness. * * * Patience is needed with those persons who are not of the usual type.

Nothing can be more helpful to an enterprise than a favorable impression made on first contact. Swindlers of all kinds know this well. Shall the children of darkness be wiser in their generation than the children of light?

The Restless, Unstable Worker

There is the worker who lacks tenacity, stability, persistence. He is hard to keep on the reservation, especially when there is an unusually fine display of new scientific fireworks going on elsewhere.

[4] Young, Kimball. "The Need of Integration of Attitudes among Scientists." The Scientific Monthly, 18: 291–305, March, 1924.

[5] Millikan, R. A. "Science and Society." *Science*, N. S. 58: 293–298, Oct. 19, 1923.

[6] Anonymous. "Suggestions for University Employees." University of California, October, 1924.

Jacob (Gen. 49: 4) cursed Reuben, his firstborn, with the words, "Unstable as water, thou shalt not excell." Pearson[7] (p. 71) speaks of him frankly:

> Stability is a trait which is often given too little weight. Some of the ablest men are affected with a restlessness which impairs their usefulness. We need investigators who will devote a lifetime, if necessary, to a single problem instead of pursuing the latest scientific fad.

Brooks,[8] too, in speaking of lack of a sense of moral obligation, describes the unstable worker.

> This lack is shown by the dilettante type of investigator, who flits from one problem to another and seems to think that he fulfills all obligations if he simply remains on the government payroll.

The Dilatory Worker

The dilatory worker is always with us. He is of three kinds, the lazy, the undisciplined and the cautious. Of him Brooks[9] writes:

> Some investigators need constant spurring to obtain results, . . . the procrastinator often receives undue credit among his colleagues from the very fact that he has failed to make the evidence of his attainments public. Indeed, he often hampers the advance of science by occupying a field to the exclusion of others and by discouraging financial support for the organization to which he belongs.

The lazy type is content to float with the current. He may enjoy reading and frequently keeps well informed. He usually is a good mixer and may be also a helpful counselor on problems. But he is a laggard in producing research results, especially in form for publication, and usually does not inspire his assistants.

In the type dilatory because undisciplined, Brooks[10] would "include the investigator with a brilliant mind, which, however, is so undisciplined that it can not be made to formulate conclusions." In a sense, of course, both the lazy and the cautious also are undisciplined. The type of mind to which Brooks refers is relatively rare.

The cautious researcher who delays production of results usually is a man of excellent judgment in scientific matters, due to his habit of weighing all data with the utmost care. However, undue caution is weakness. Dr. Brooks[11] portrays him as follows:

> Most often, however, the procrastinator is the hardest working of men, and his unwillingness to put forth conclusions is due to his fear of omitting some detail or failing to fully test some theory. We must respect such a seeker of truth, yet a part of his fault may lie in a certain conceit which induces him to believe that his results are so epoch-making that he trembles for the consequences to the nation if they should be announced prematurely.

Over against these types set the researcher with an international reputation for splendid accomplishment whose manuscripts appear in a steady succession and written in clear, concise and accurate form. Yet this man admits that, for him, writing is pure drudgery, although research under difficult, unpleasant and even dangerous conditions is sheer joy. His sense of moral obligation to do always his best impels him to make his presentation as finished as his investigation.

The Over-hasty Worker

Worse than the dilatory scientists are the ones with no speed limit. Their premature, half-baked papers are everywhere before us, requiring our time and effort out of all proportion to their value. Administrative superiors who allow them to foist their unproved or half-proved theories on the public in the name of science are to blame for much of this

[7] Pearson, G. A. "Some Conditions for Effective research." *Science*, N. S. 60: 71–73, July 25, 1924.

[8] *Loc. cit.*, p. 93.

[9] *Loc. cit.*, p. 92.

[10] *Loc. cit.*, p. 93.

[11] *Loc. cit.*, p. 93.

abomination. Editors who accept papers of doubtful accuracy of conclusion bear also a measure of responsibility. Brooks[12] expresses the sentiments of many when he says:

> Another problem in personnel is presented by the scientist who is as quick as a hair trigger in publication. He boldly rushes into publicity where the more experienced investigator fears to tread and, though he may be endowed with a certain superficial brilliancy, he is too impatient to carry his researches through to the end of establishing conclusions. His contributions may be likened to skyrockets—they illuminate the scientific landscape for a moment, only to fall to earth and leave us in darkness. Such men are sometimes the pests of scientific literature, . . .

These publicity artists are indeed the pests of science. Brooks referred to them as receiving swift and sure punishment, but that is not always obvious to the onlooker.

Possible Selection of Personnel

Does the reader ask, "Why talk so much about these objectionable personalities and so little about the many splendid workers?" It is for the same reason that the daily press devotes so much space to murderers, bootleggers, bandits and bigamists, and so little to respectable and law-abiding citizens like you and me. This is not because criminals are more numerous, for relatively there are but few. It is not merely because we have a human curiosity to know the other fellow's meanness. It is because these are the problems of society, just as objectionable personalities are the problems of research administration. We all must talk about our problems.

Was it Mark Twain who said concerning the weather, "Everybody talks about it but nobody does anything about it." Is there anything that can be done about the matter of suitable personnel for research? There are three possibilities. Researchers are trained workers. Selection may be practiced on them before they begin training, or during the period of training, or after the preliminary training is completed. They may be sorted from the research standpoint while yet in high school, or during the college course, or after graduation and before entering upon investigation. Can the possibility of genius and adaptability in research be determined with any certainty in any one of these three periods? If so, the effort would seem not only to be justified but to be a definite obligation upon us. Our duty is to get the best personnel we can and to make the best use of what we get.

Selection in High School

We hear much nowadays in educational and industrial circles about selection of students and employees. Such phrases as character analysis, psychoanalysis, stimulating latent abilities, finding one's place in life, fitting the job to the man and similar ones are ever before our eyes. Where there is so much smoke there surely should be some fire. Professor C. E. Seashore,[13] head of the department of psychology in the State University of Iowa, recently has published a paper on this subject under the title "Recognition of the individual." His discussion of the need and plan for progress in this line is worthy of our thought.

> The great tragedy of all higher education today is the maladjustment, failure and misdirection of the student entering college on the towering and surging wave of "education for democracy." From 5 to 50 per cent. of freshmen fail and are eliminated in the first year. These students are sent back to home and community disgraced and disheartened, and constitute not only an economic waste, but a gross maladjustment of human energies, hopes and ambitions.

[12] *Loc. cit.*, p. 94.

[13] Seashore, C. E. "Recognition of the Individual." *Science*, N. S. 60: 321–325, Oct. 10, 1924.

For this there is a simple remedy, and that is to develop a nationally standardized college qualifying examination which shall be given at the end of the senior year in all high schools and preparatory schools as a basis of information with reference to fitness for college work. On the basis of this examination parent, pupil and teacher may make a rational estimate about the wisdom of going to college; and this examination, which is given merely for information, will be accompanied by expert analysis and advice in general principles of vocational guidance with reference to the outlook for persons of the various degrees of fitness for higher education.

Such an examination is being developed under a five-year experiment now in progress. Two thousand high school students are examined annually. Prediction of probable success is made and this is correlated with the actual achievement of those who go to college, wherever they go. Thus we shall have a quantitative measure of the degree of precision of our power of prediction. The preliminary findings are exceedingly gratifying in this respect.

Professor Ogden[14] in a paper on "The Purpose of Research" asks certain questions relating to the abilities of students. His third question is pertinent to a discussion of prospective students:

What tests can be applied to candidates for admission to the college of agriculture to determine their fitness for directing dairy work, or for agronomy, or for any other kind of agricultural work?

Curiously enough, Professor Seashore six years later (*l.c.*) provides an answer to the question in the following words:

Now at this stage we can not distinguish between the engineering and other professional or liberal arts students. It is enough to know that that student who is fitted to go to college is encouraged to do so, ...

Selection in College

The important period for determining the fitness of a man for research is while he is in the making, as a student in college. Here he is under the almost daily observation of several teachers and his characteristics as well as his various abilities may become known. In these four years a cross-section view of his future possibilities should be had. The record should go much farther than his mental progress and promise. It should contain data on the characteristics, desirable and undesirable, which have been discussed in this paper.

Ogden[15] asks the following questions regarding the working conditions favoring productive mental effort on the part of college students:

What is the necessary rest period during the course of any working day? Do students accomplish the same amount of work in the same number of days of a term, with and without vacations? . . . How shall a student know when he has reached the limits of his powers of application in the preparation of any lesson, so that a change of occupation is desirable?

Seashore[16] suggests placement examinations on entering college in order that "we shall start our student rightly at his natural level for achievement." In the third paragraph previously quoted he states that the indications given by the high school examinations are checked up during the college course. The experiments he describes are only a beginning, but they give promise that some day we shall know much more about the character and ability of college students in science than is at present possible.

Selection after Graduation

Where does the personnel of experiment, investigation and research come from and how does the organization acquire it? Trained personnel must come from the institutions of higher education. The lines of research in the U. S. Department of Agriculture and in the state agricultural experiment stations are chiefly agricultural. The personnel for this work, therefore, comes chiefly from the college of agriculture. In this de-

[14] Ogden, H. N. "The Purpose of Research." *Science*, N. S. 48: 525–532, Nov. 29, 1918.

[15] *Loc. cit.*, p. 528.

[16] *Loc. cit.*, p. 322.

partment and in the similar institutions of some states, the scientific staff is obtained through the medium of civil service examinations and appointments. These are designed to test the ability to answer technical questions, covering a rather varied but still narrow range of specialization. This procedure is supposed to establish the fact that the prospective worker has knowledge of a subject. Appended to these examination papers are certificates of two associates, stating that the worker is believed to be of good character and fitted for the work. These merely insure that we do not acquire persons of bad moral character or with prison records, at least not without knowing of it beforehand.

But what about the possession or lack of the personal attributes named above? So far as known not one single attempt is made anywhere to discover whether and to what degree the prospective researcher has all or any of these characteristics. He may be lacking in mental honesty and accuracy. He may rank low in imagination and initiative. Such qualities as energy, persistence and judgment may be wanting. He may be selfish, suspicious and stubborn instead of loyal and cooperative. How shall these facts be known before a worker is engaged?

It would be a very simple matter to make a start. Require each applicant for admission to a civil service examination to submit the names and addresses of three or five persons qualified to give reliable information on questions of personality. To each such person send a rating sheet on which the degree of possession of certain desirable and undesirable characteristics may be clearly indicated. Transmit these estimates of character to the prospective employer with the ratings on scientific ability. It is a fair guess that in the end there would be definite endeavor to control and eliminate such characteristics as tended to prevent appointments.

It is interesting to note that for several years the experiment station subsection of the section on agriculture in the Association of Land Grant Colleges has considered personnel matters at its meetings. During the past two years, a subcommittee of their committee on experiment station organization and policy, under the chairmanship of Director R. W. Thatcher, has considered a code of ethics for station workers. At the meeting of the association in November, 1924, the revised code submitted by Dr. Thatcher[17] and his associates was finally adopted. Among other things it covers questions of honesty, stability, accuracy, promptness in publication and cooperativeness.

Concluding Questions

In conclusion, let us ask ourselves frankly if any obligation rests upon us as individuals or as an organization to better the conditions described. The writer believes that all the following questions should be answered in the affirmative.

(1) Is there an obligation upon the service to devise means by which the characteristics of prospective appointees may be more definitely estimated before appointment?

(2) Is there an obligation upon the service as a whole, and upon the individual administrator in it, to weed out the markedly unfit of whatever kind in order to improve the service and to render a more satisfactory account of his trust?

(3) Is there an obligation on administrators of all ranks to endeavor to point out to the individual employee those

17 Thatcher, R. W., *et al.* "Report of Committee on Experiment Station Organization and Policy." Proc. Am. Conv. Assn. Land Grant Colleges, 38: 225–228 (1924), 1925.

characteristics to which they appear to be strong and also those in which they appear to be weak, and by counsel and suggestion endeavor to make each individual a better public servant?

(4) Is there an obligation on the part of the individual worker to strive to get a wider view than his own particular job, to try to get the viewpoint of the immediate unit to which he belongs, of the larger unit of which it is a part, of the entire department in which he serves and of the entire federal service as a trust to be administered of the people, by the people and for the people?

(5) Is there an obligation on the individual worker to search for their own weak spots and to endeavor to strengthen them? A rating system has been put into effect by the U. S. Personnel Classification Board in an attempt to determine the relative abilities and values of the workers in the federal service. Would it not be a helpful thing if all workers were to fill out such a rating sheet for themselves, trying honestly to determine the characteristics in which they were strong and those in which they were weak? Would not the result be a conscious effort at self-improvement?

So nigh is grandeur to our dust,
So near is God to man,
When Duty whispers low, "Thou must,"
The Youth replies, "I can."—*Emerson.*

SUCCESS

By Professor A. S. PEARSE
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WHAT every man most desires is to be successful. What puzzles most of humanity is how to do it.

If one asks a business man for the secret of success, he says, "Boy, make money—and save it!" If the socially successful one is "among those present" at the most "stylish" functions and can associate with "aristocrats," she has "arrived." The scholar works years in order to publish a few pages that he hopes may be commended, perhaps a century later, by some fellow of like kidney. The rector asserts that if one is good and trusts in God, nothing else matters. The politician strives to "manage the masses." Which of these is seeking real success?

The New York *American* cleverly remarks, "Success is getting what you want; happiness is wanting what you get." Professor Witmer, who is a psychologist and should know better, says that success is the attainment of "what the individual himself deems worth while."

Such primitive attitudes of mind of course amuse biologists. We have long known what success is, and we regret that a youth who is trying to attain some degree of mental stability can read, as the opinion of a competent scientist like Professor Witmer, that success is only that which makes an individual satisfied with himself. All biology cries out that success is more than that! One with a scientific attitude of mind and who is continually trying to think clearer can not be satisfied with any epigrammatic, or even with an inadequately pragmatic, definition of success. Real success is a continual reward and a continual obligation.

Without competition there can be no success. Victory depends on winning a race or a fight or some other contest for a leading position. So far as it applies to the lives of men and other animals, success is usually the product of intention and effort, not the result of luck or chance. In the language of Charles Darwin, it is excelling in a struggle. A current dictionary says it is "the successful issue of a thing attempted."

In order to make the biological aspects of success clear, the reader is invited to consider briefly the characteristics of a successful plant and a successful animal —the dandelion and the housefly. From a biological point of view the *survival* of a particular species of animal in the struggle for existence may be considered as evidence of a certain level of success-- if an animal is alive, it is to some degree successful. If a species also occurs in great numbers and is able easily to make a living over a considerable portion of the earth, it is to be looked upon as having attained a higher level. Any one who has practiced swatting flies or tried to keep a neat lawn knows that the fly and the dandelion have won many victories over the human race. In fact, from man's point of view, they are ubiquitous, disagreeable pests that ought to be eradicated but have not been just yet. They have beaten man—old *Homo sapiens* himself.

What is the secret of the success of these organisms? Our enemy, Sir Fly, is keen of sense, agile, versatile. Having his skeleton on the outside and his muscles within, he has done what human mechanical engineers say is the best thing for him—*i.e.*, gradually through the ages become small and quick. Now

he is able to occupy a considerable part of the little nooks on the earth. He escapes with ease from the attacks of sluggish, bulky animals that have bunches of soft muscle on their exteriors and bones within. Among animals of his own kind Sir Fly represents the best that has been produced. Mechanically his equipment for struggling shows the highest degree of perfection. He has the "latest models" of wings, eyes, feeding organs, legs, etc. To be sure, Sir Fly's shield has a bar sinister across it and his escutcheon bears a blot or two. Some of his ancestors were awkward worms with legs through the whole length of their abdomens. They had no smooth and rotund surface like that his highness polishes so proudly to-day. Sir Fly's great-grandfather was glad to gnaw food off in great chunks and bolt it down, instead of delicately rubbing it into polite bites with a beautiful rasp-ended tongue. But while biologists like to rake up these scandals about Sir Fly's family, we have to admit that he stands to-day the peer of any insect, and ever our astute and capable enemy.

But this is not all—Sir Fly has kept his versatility. Equipped with all the best types of arthropodan structures, he is not confined to one narrow mode of life. The poor honeybee has put all his eggs in one basket. If he can not find sugar to eat, he is lost. But our enemy, Sir Fly, can eat sugar or meat or fat or any mixture of such foods, and flourish. A bee's egg that is separated from its brood comb and its attentive swarm of nurses produces a little grub that soon perishes. A fly maggot can live on a wide variety of foods and withstand great variations in moisture, temperature and other conditions of environment. It is apparent that there must always be more flies than bees in the world. We men may not like to do so, but have to admit that Sir Fly is a success. He fights, survives; yes, he dictates: Build screens on your houses, boil your water, cover your food!

Our enemy Baron Dandelion is equally perfected and versatile. In his physical makeup are tubes for carrying milky secretions; polygonal, spiny pollen grains that do not easily roll off when they lodge on a stigma; aeroplanes for transporting ripened seeds—many of the latest developments in plant structures. If we order the baron off our estate, he digs deep to a water supply, spreads out flat to keep our allies away from his commissary, and makes a stubborn fight. On the other hand, if he appears in our flower garden, he does not spread out at all, but grows up tall and thin. Baron Dandelion is not an unprogressive, stubborn bigot, either, but a keen, resourceful enemy. One instance of his progressive spirit, and we will let him pass. Through long years and ages dandelions have been developing beautifully colored flowers—composite flowers of the most specialized type—but recently these flowers (though still retained and accorded a certain position on account of an edict from King Heredity) have lost their function. Their bright colors are now of no avail. Like so much archaic machinery in a progressive factory, they have fallen into disuse because dandelions learned to fertilize themselves, and therefore the mechanisms associated with cross-fertilization are no longer necessary.

All this introduction leads up to Theorem I in the Biological Book of Success:

Theorem I. *Successful and progressive plants and animals survive in the struggle for existence by being specialized, yet versatile.*

There are many who have false standards for success or are satisfied by pseudo-success. For those who say, "Why struggle when it is not necessary? Why not invent something, or write a book and live on the royalties?" I can only answer that there is no greater biological sin than to cease to struggle. It is not wrong to have a billion dollars or a presidency or a title or a good name.

The unpardonable sin is in saying, "I have done enough," or "I have enough," or "I have earned a rest." Biological evidence for this point of view is to be found in the past history and present lives of many animals. Coming from swimming ancestors with eyes and other organs that gave some degree of appreciation of the world, the barnacle to-day lives attached to rocks along the seashore, safely encapsuled in a stony wall, kicking its legs in the water to capture food. Certainly the barnacle has a sure supply of food and an easy life. Again, the tapeworm leads a quiet, protected life in the midst of digested food. Indeed, it lacks organs of digestion completely and has no sense organs for finding food, or for recognizing other particular qualities in its surroundings. Tapeworms appear to have descended from ancestors that lived a free life, seeing, seeking, fighting for their place in the world. Why not be a parasite? There is some prejudice against it, but why not?

Theorem II. *The degree of ability and appreciation that any living plant or animal possesses is more or less directly proportional to the amount of struggling that the organism has done. Lack of struggling is always associated with degeneracy, with loss of power and of accomplishment and appreciation.*

Then there are those who would condone another damnable biological sin—deceit. A man says: "I have got to make a living. What harm if I deceive the world to do it; especially if I actually injure no one?" Deception has long standing as a means of existing among animals. Spiders spin delicate webs that are overlooked by careless or stupid insects. Decorator crabs cover their backs with objects that they select from the sea bottom and thus escape detection. A walking stick is camouflaged in form and color to resemble a twig and puts all its faith in this resemblance. If one of these insects is disturbed, it may hold the same position for several hours (if it moves, it no longer resembles a stick) and will allow its body to be cut in two without giving any sign of life. If such means secure a living, why not use them? From a biological point of view they may be said to be expedient, but dangerous, because animals employing them are led to depend more and more on special means, and if deception is discovered, the game is up. Prolonged rains may prevent the building and repair of webs, and spiders starve. If a decorator crab falls on a clean sandy bottom and attempts to move about, it is discovered and snapped up by some hungry fish; if a wind carries a walking stick away from twigs and stems, it is easily seen. If an actress that depends on a $10,000 gown to win her audience loses her trunk, she loses her audience too. If a shyster lawyer or a quack doctor is found out, the law removes his accustomed means of livelihood.

Theorem III. *Avoiding the struggle for existence by deception is dangerous because plants or animals that use such methods tend to become dependent on special means and if these are discovered, organisms will be greatly handicapped or eliminated from the struggle.*

Another means of struggling is through the cooperation of many individuals. Men, ants, termites and other animals have attained considerable success with this method. It undoubtedly has the advantages of the strength that comes with united effort and the high degree of attainment that is possible through the work of cooperating specialists. In ant colonies structurally different castes are present, which are specialized as workers, soldiers, doorkeepers, etc. In general the cooperation that is an essential feature of social life is beneficial to the colony, but it always entails a lack of opportunity for the full development of the individual. Communism tends to reduce all to the same level of mediocrity and makes the development of outstanding individuals more difficult.

Another great defect that is always associated with social life is parasitism. No two individuals are ever of equal ability and some members of any community are abler and do more work than others. Some individuals are so incompetent that they contribute nothing and are supported by the community. Furthermore, real social parasites intentionally insinuate themselves into communities, where they make no attempt to do anything but make a living for themselves. Some two thousand species of social parasites have been recorded as occurring in ants' nests. In human societies there are always parasitic individuals or castes which shout for cooperation and gain a living from others, but contribute nothing themselves.

Theorem IV. *Cooperation is one of the best means of attaining success if it does not involve too great sacrifice of individuality or waste effort on social parasites.*

The animals that lived in past ages give some insight into the meaning of success. At one time marine invertebrates dominated the earth. Then the old ostracoderms and fishes came in and were the most astute and capable animals for a time. Later amphibians appeared and were able to invade parts of the earth that fishes had never reached because they acquired the ability to breathe air and hence could go on land. Then came the Golden Age for reptiles, and hundred-foot monsters roamed over the continents. These gigantic animals ran their course and were succeeded by the smaller, but swifter and wiser, birds and mammals. Probably the dominant animals in each age patted each other on the back and said, "How good we are! There has never been anything like us before!" Most of them are wholly extinct and the earth will never feel their influence again. If you ask a paleontologist what the usual cause for the dying out of a race of animals was, he will probably answer, "Too much specialization." The dinosaurs, for example, attained gigantic size, but were unprogressive in other lines of development. The earth environment changes markedly from time to time—there have been glacial epochs, humid periods, arid periods, etc. If an animal is highly adapted to peculiar conditions and these change, the animal becomes extinct. Every one knows that in human society too much specialization is unwise. A city blacksmith who has done nothing but make horseshoes all his life may find it difficult to make a living in his old age because he is ignorant of the ways of repairing automobiles.

Theorem V. *Specialization is desirable but must not be so narrow that an animal can not take advantage of new types of opportunities and change activities with changing conditions.*

Enough of argument! Now, what is success? The evidence from biology acclaims to the world: "Struggle and improve. It is sinful to be narrow, lazy (or even contented?), deceitful or blindly cooperative. It is virtuous to be industrious, ambitious, honest and considerate." Probably the most important tool for success is eternal trying. Men succeed in all fields of human endeavor and often do not realize how they have reached their goal. President Eliot, who was trained as a chemist, ascribed his success to hard work; the great general, Napoleon, to foresight; the business man, Bradley, to necessity; the evangelist, Moody, to cooperation. Holmes showed his wonderful insight when he said:

> I find the great thing in this world is not so much where we stand as in what direction we are moving. To reach the port of Heaven we must sail, sometimes with the wind and sometimes against it, but we must sail, and not drift nor lie at anchor.

Law. *Success is continual improvement.* It is also the most important milestone on the road to happiness.

WHAT SCIENCE OWES THE PUBLIC

By AUSTIN H. CLARK

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We have heard much, in recent years, of what the public owes to science. The telephone, the automobile, the aeroplane, the radio, the X-ray and many other things, commonplaces at the present day, are commonly brought forward as concrete examples of groups of correlated achievements in pure science now finding practical application for the good of all.

Nobody has denied, or could deny, the appreciation of the public for these benefits. It is evident in popular books, in the magazines and in the daily press in ever-increasing volume. The evidence consists of a flowering of interest in science in this country, which is without precedent in this or any other land.

These startling achievements, all products of pure research, have forcibly impressed upon the public the concrete significance of science to itself.

Science has become democratized, and by so doing has chiefly been responsible for that fundamental change that has taken place within the last few years in our social system obvious to any one with any powers of perception aptly called by Professor Carver a social revolution.

This social revolution has resulted in a wonderful improvement in the condition of our so-called humbler classes over what it was even two decades ago. The incomes of the small tradesmen and the laborers, now actually large and made relatively larger still as a result of greatly increased efficiency in the production and distribution of the products of our farms and industries, due to the broad and general and increasing, though commonly unnoticed, application of scientific facts, now permit them to enjoy very many of those luxuries which even fifteen years ago were considered as possible only for the rich. The automobile, the "movies" and the radio, the telephone and a host of other things now are regarded as essential to the well-being of a very large percentage of our population.

These luxuries of the very recent past, now become essentials, all have one thing in common. Their use of necessity results in a broadening of contacts.

Broadening of daily contacts goes hand in hand with broadening of interests and of vision. We are beginning to discover that what we hitherto have called superior intelligence is very often nothing more than the mental attitude produced by more numerous and more intimate contacts with the varied activities that take place beyond the normal orbit of one's daily life.

Now that they share with their more affluent fellow countrymen most of the material luxuries of life, those occupied with the humbler lines of work are sharing also more and more in their mental attitude toward science. They appreciate its benefits, and they wish to learn all they can about it. And this desire for enlightenment is coupled with increased insistence that what they learn be accurate.

Here is the great responsibility of science in this country at the present time, to take the public into its confidence and to inform it of what is going on, to form a partnership between the scientific workers and the great mass of the people which shall result in mutual benefits.

Why is this necessary? Because in any country progress in science is and

always has been dependent on the active appreciation of an interested public. The theory that it is the hobby of the rich and leisure classes and that it can be advanced effectively by the restricted patronage of a Louis XIV is quite untenable. Isolated steps may be taken in such a way, but a great sound body of science can no more be built up without the interest and backing, indeed even the participation, of a large section of the public than the cathedral of Chartres could have been built by the nobles of Beauce alone.

No one can deny that England, with her Newtons, her Faradays, her Darwins, her Lubbocks, leaders in every branch of science, holds first place in the discovery of basic scientific principles. It is equally undeniable that interest in science among the population as a whole is, or at least until recently has been, greater in England than in any other country. In England there exist very many scientific societies with a membership made up largely of working men and tradesmen. The relationship between these two sets of facts is beyond question.

What were, and are, the conditions in America? Fifty years ago this section of the public was relatively small; the majority of the people took little interest in anything further than getting enough to eat and the most elemental comforts. Their outlook on the world at best was purely local, and generally they paid no heed beyond an idle curiosity to affairs outside their daily round of life in their own town or state.

The modern developments in transportation and communication, especially the organization of these services into units nation wide and even international, has changed all this. The great majority of our population is now awakened and alert; no longer apathetic, our people wish to know what science is and what it means to them.

In the old days science in America was for the most part the recreation of the rich or well-to-do, and these were the only classes interested. Conditions are quite different now. Why? Because the more or less isolated scientific facts developed and established as a pastime by the leisure classes in the past have now been correlated, formulated into broad principles, further elaborated and applied for the good of all. Science itself has brought about this change by attracting the interest and gaining the confidence of an ever-increasing clientele.

But by doing this science has brought upon itself a grave responsibility, that of satisfying the interest it has itself created. Why is this true? Because of the dependence of science on intelligent popular appreciation. This dependence is at once apparent in all those institutions that are supported by federal or state appropriations. It is at once apparent also in the great industrial concerns that sell their products to the public. It is less apparent in institutions supported by endowments. But if such institutions are popularly believed to serve the public interests their endowments will increase proportionately; if not, they gradually will decrease in influence and possibly will be cut off altogether. Though not so obviously or so immediately responsive to the popular will, endowed institutions are nevertheless ultimately dependent on it, and that dependence is becoming more and more pronounced.

Here we seem to have an impossible situation, institutions engaged in specialized research work dependent for support upon a public with no knowledge of the intricacies of the subjects studied. How can they ever get together, as they must if what has just been said is true?

How was it that isolated scientific facts were assembled, coordinated and applied for the public benefit? This

came about not through the work of the scientific men themselves, but through that of intermediaries, jobbers if you will, men more of business than of science, who visualized the possibilities in the mass of facts available and made use of them.

In the same way the results attained by the research worker must be coordinated, sifted and interpreted to be intelligible to the average man.

It is a common fallacy that progress in science has resulted from the labors of devoted individuals working long hours by themselves, mostly without adequate reward. This is not so. It is quite true that the great bulk of scientific detail has been gathered by men of whom the public seldom hears, men wholly devoted to their work and deserving of the highest praise for their disinterested labors. But the busy world has little time to ponder and appraise their efforts in detail.

Progress in science has resulted from popular appreciation of its interest and value. This has been brought about through the work of intermediaries able to explain it to the populace at large. Just as science has been applied for the common good by men who were rather business men than men of scientific bent, so science has mostly been explained by publicists rather than by research workers.

The great men in science have been those like Lamarck, Agassiz, Darwin, Huxley, Tyndall, Rayleigh, Lubbock and many others, who were both scientific men and publicists combined, outstanding research men who wrote and talked in terms the average intelligent man could understand, secured his interest, and thus made the work of all the others possible. It made little difference whether these men were right or wrong in their ideas. They secured the public interest; this once aroused, infinite discussion was made possible and all the facts brought out. Millions of dollars have been spent by publishers of books, magazines and newspapers in printing material bearing on Darwin's work. Thousands of scientific men, under the stimulus and protection of the interest thus aroused have brought innumerable facts to bear upon the subject.

So much for the intermediaries of the past. What of those to-day? At the present time we have a vastly extended and more alert interested public, anxious to be informed and also anxious to know how they are affected by developments in science. We have an ever-increasing number of devoted men engaged in highly specialized work of whom the general public never hears, but whose work is of the most fundamental and vital character, and forms by far the largest and most important part of our scientific output. We have no lack of able men, like Millikan, Merriam, Michelson, Howard, Osborn, Shapley and many others who, leaders in their several lines of science, have not lost contact with their fellow men and can therefore speak to them in simple language that they can understand, carrying ever forward the work of their illustrious predecessors. And we also have a growing corps of writers, capable, honest and sincere, whose one aim and desire is to further science by describing and explaining in the magazines and newspapers the new discoveries now almost daily made.

Many of our scientific men are apt to look a bit askance at these representatives of the press. They doubt their honesty of purpose and their ability to report correctly what they hear. For the most part the fault lies with the scientific men themselves, who are unable to explain their work in such a way that it can be understood by others who approach the subject from a wholly different angle. It is a common human failing to explain one's weakness to oneself by assuming that the fault is with the

other fellow. Most of us fail to see in a misquotation in the press a reflection on our own clarity of expression, though that is very often what it is.

Let us compare the research worker with the publicist. We who are immersed in research know that before we can produce results of value in their broader application a probationary period of from ten to fifteen years is necessary, even after an intensive college education. Always to every man the other fellow's work seems easier than his own, since he sees only the outstanding features and is ignorant of the maze of detail on which these are based.

The successful scientific man too often looks upon the publicist as a sort of lucky being who by the easy process of writing for a few hours every day can command a handsome income.

The successful writer knows too well that years of patient unrewarded effort full of discouragements of every kind, a grueling apprenticeship more severe than that of the average scientific man, working usually under the protection of some powerful institution, must pass before he finds his place.

He on his part, remembering these years of bitter strife, is prone to regard the laboratory worker as leading a life of ease and comfort, if not, indeed, of semi-idleness, protected by his institution from the jealousies and envies of his fellow men.

What science owes the public is a greater extension and expansion of all lines of contact with the people as a whole. Let us show more confidence in our fellow men. Let us be frank and open with them. If we who are engaged in science let the people know what it is we do and what it means to them every one will profit.

THE VITALITY OF THE PEOPLES OF SOUTHERN INDIA, IT'S CONSERVATION AND PROMOTION[1]

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The Peoples of Southern India

To the untrained eye of the ordinary untraveled European on first arriving in Southern India, all Indians are black, all have the same cast of countenance, and all except the "decently naked" labouring classes wear loose garments which revive dim memories of the attire of the ancient Greeks and Romans. The first step in the observant man's education is to learn to tell a Hindu from a Mohammedan, and a further stage is reached when it dawns upon him that the upper classes of Hindus are much fairer than the lower, and that their features are moulded on finer lines. Later on, as opportunity favours him, he learns to distinguish what may be called the provincial types of the people of India.

The skin color of the different types presents extreme divergencies, that of the Dravidians of Southern India being bright black, and aptly compared to the color of strong coffee unmixed with milk. "Of the Irulas of the Nilgiri jungles some South Indian humorist is reported to have said that charcoal leaves a white mark upon them." Amongst the higher castes, of course, the skin is frequently quite fair. The hair of the great mass of the population of South India is black or dark brown, but carroty hair is not unknown among the Syrian Christians of Malabar and South Travancore on the west coast of the peninsula.

The nasal index, *i.e.*, the relation of the breadth of the nose to its length, gives a very accurate gradation of racial type. For those parts of India, like Madras Presidency, where there is an appreciable strain of Dravidian blood, it "is scarcely a paradox to lay down as a law of the caste organization, that the social status of the members of a particular group varies in inverse ratio to the mean relative width of their noses. The broad nose of the Negro and of the typical Dravidian is his most striking feature, and, in fact, the typical Dravidian as represented by the Pahars of South India has a nose as broad in proportion to its length as the Negro." Some writers, indeed, describe the Dravidian under the name of Negroid, but the two are in no way related.

In Southern India the stature is generally lower than in the plains of the north, the minimum being found in the Negritos of the Andaman Islands, and the mean as low as four feet ten and one half inches.

Of the seven physical types mentioned by Risley, the Dravidian is to be found in that part of India stretching from Ceylon as far north as the United Provinces and Central India. When Madras, however, is called the Dravidian home, that does not mean that all the people of Madras are of the predominant type.

From time immemorial a stream of movement has been setting from north to south, a tendency impelling the higher types towards the territories of the lower. During the course of the movement, Indo-Aryan types have spread all over India as conquerors, traders, landowners; and in Madras, which is furthest removed from the Indo-Aryan settlements in North-West India, members of the upper castes are still

[1] Papers from the Department of Biometry and Vital Statistics, School of Hygiene and Public Health, Johns Hopkins University, No. 112.

readily distinguished by their features and complexion from the mass of the population.

The Dravidian race is the most primitive of the Indian peoples, occupying as it does the oldest geological formation in India. Huxley considered that the Dravidians might be related to the aborigines of Australia, but Sir Wm. Turner's later studies have cast doubt on their Australian affinities. "The present peoples of Southern India are therefore a mixture of the ancient Dravidians with the invading Indo-Aryans, the type being precisely what might have been expected to result from the incursion of a fair long-headed race traveling by a route which prevented women from accompanying them into a land inhabited by dark-skinned Dravidians. The degree of intermixture varied," but writers of the Indo-Aryan school maintain the predominance of the Dravidian element in the present population.

The Hindus of Southern India, numbering in all about 37 millions, may be divided into four great classes or castes, *viz.*, the *brahman*, the *shastriya*, the *vaisiya* and the *sudra*, the lowest of all. In order to give some idea of the complexity of the social system involved in the word caste, an illustration used by Sir Herbert Risley some years ago may be adopted.

Take the great English tribe of "Smith," the "noun of multitude," as it has been called, and imagine it transferred into a caste organized on the Indian model. The caste would trace its origin back to a mythical eponymous ancestor, who took his name from the smooth weapons he made for his fellow tribesmen, and, bound together by this tie of common descent, they would recognize as the cardinal doctrine of this community that a Smith must always marry a Smith and could by no possibility marry a Brown, a Jones or a Robinson. Over and above this general canon, three other modes or principles of grouping within the caste would be conspicuous. First, the entire caste of Smith would be split up into a multitude of "in-marrying" clans, based on all sorts of trivial distinctions.

Brewing Smiths and baking Smiths, hunting Smiths and shooting Smiths, temperance Smiths and licensed saloon Smiths, Smiths with double-barrelled names and hyphens and Smiths with double-barrelled names without hyphens, democratic Smiths, republican Smiths, tinker Smiths, tailor Smiths, Smiths of Maine and Smiths of Maryland, "all these and all other imaginable varieties would be crystallized by an inexorable law forbidding the members of any of these groups to marry outside its own circle." The "dry" Mr. Smith could only marry a "dry" Miss Smith and might not think of a "wet" damsel, the free trade Smiths would have nothing to say to the protectionists.

Secondly, within each class we would find a number of "out-marrying" groups governed by the rule that a man of one group could in no circumstances marry a girl of the same group, *i.e.*, the converse of the first. In theory each group would be regarded as a circle of blood kindred, and marriages within the limits defined by the group name would be deemed incestuous. In these circumstances the group name descends in the male line and would of itself present no obstacle to a man marrying his grandmother. Thirdly, each marrying class is broken up into three to four smaller groups which form a sort of ascending scale of social distinction. Thus the class of hyphen-Smiths, the cream of the caste, would be again divided into, say, Episcopalian, Presbyterian and Salvationist hyphen-Smiths. The rule would be that a man of the Episcopalian group might marry a girl of his own or the other two groups, a man of the Presbyterian group might marry into his own and the Salvationist group, and a man of the Salvationist group might marry only into his own group. A woman could under no circumstances marry down into a group below her own. Other things being equal, two thirds of the Episcopalian girls would get no husbands, and two thirds of the Salvationist men no wives. If we suppose the various aggregates of persons bearing the two to three thousand commonest English surnames to be formed into separate castes and organized as above, the mental picture thus formed will give a fairly adequate idea of the bewildering complexity of the Indian caste system.

Even Christianity has not altogether escaped the subtle contagion of caste,

and everywhere in India there is a tendency for converts from Hinduism to group themselves according to the castes to which they originally belonged. That is more true of the Roman Catholics, as the Catholic Church tolerates this idea of caste, while the Protestant Church condemns it. There seems to be no likelihood of caste being banished from Indian soil "until Brahmanism itself—*the fons et origo mali*—has died a natural death by the use of the scientific spirit, and the fallacy of its pretensions has become an object of general scorn." As soon as the Brahman begins to disappear, the rest will follow.

The following table, giving the numbers of caste sub-divisions among six of the chief castes for the four main languages of Southern India, will demonstrate the complexity of the system:

among the pariah Hindus, and whole castes have been known to become Mohammedan because the Brahman would not allow them to enter the Hindu temples, but compelled them to worship outside. Even to this day there are certain streets along which none but Brahmans may pass.

Christianity has had considerable success in Southern India, especially among the depressed classes, there being over a million Christians now in Madras Presidency. "To the pariah it promises release from a relentless form of social tyranny, the tyranny of caste, and it offers them independence, self-respect, education, advancement and a place in an organized and progressive society." As a matter of fact, the pariah, whose mere vicinity pollutes, has traditions which point to the probability that his status was not always so degraded as we find it at the present day.

	Tamil	Telegu	Malayalam	Canarese
Brahmans	43	80	20	80
Vellalars, or agriculturists	175	404	55	169
Chettiars, or merchants	59	29	13	17
Kshatriyas, or warriors	13	17	5	14
Shepherds	48	85	17	42
Accountants, or statisticians	11	23	2	2

TABLE I

The Mohammedans, who number nearly three millions in Southern India, are in every respect the antithesis of the Hindus.

> The Mohammedan religious ideal is strenuous action rather than hypnotic contemplation; it allots to man a single life and bids him live it and make the best of it. Its practical spirit knows nothing of a series of lives, of transmigration, of *karma*, of the weariness of existence which weighs upon the Hindu mind. The Mohammedan religion is opposed equally to the Hindu scheme of a hierarchy of caste, for in the sight of God and His prophet, all followers of Islam are equal.

The contagion of caste, however, has spread even to the Mohammedans, and, in Southern India, one meets with a large number of low-class Mohammedans evidently the result of proselytism

Language

The people of Southern India have, therefore, no community of origin. Moreover, there is little community of language. The great mass of the population speaks either Tamil or Telegu, the former being found mainly in the southern districts, and the latter in the northern area. In addition, a very considerable proportion use the Canarese language, whilst to the southwest a language called Malayalam is spoken. All these tongues are more or less interrelated, being probably derived originally from the same mother tongue, but to-day a Tamil does not understand

Telegu, nor does the Malayalee automatically find it possible to communicate by word of mouth with a Canarese. The one common language in South India is English, and the writer is personally acquainted with an Indian married couple whose only means of linguistic communication is English. Most Mohammedans use the Urdu language just as they do in Northern India. As a general rule, it is necessary to be acquainted with at least two languages in order to be able to carry out peripatetic work such as must be done in the field of public health. As both the Tamil and Telegu tongues have a rich store of ancient literature, both having absorbed a great deal from the Sanskrit, it is as unlikely, as it would be regrettable, to expect that South Indians will ever adopt any one common language.

Diet

As regards food, the Madras Hindu is a strict vegetarian, rice being his staple form of diet. This is supplemented with varying quantities of green vegetables, milk and ghee, which is a form of clarified butter. The orthodox Hindu would be horrified at the idea of eating any other form of fat than ghee, but the Indian merchant is familiar enough with methods of food adulteration, and considerable quantities of so-called pure "ghee" contain high proportions of mutton and beef fat, whilst pig's fat is also not entirely excluded. The vegetable part of the diet being not always available for different reasons, and the better class Indian expressing a preference for highly polished rice, it is not surprising that beri-beri is fairly common, the more so as all milk is boiled before being consumed. Osteomalacia is not uncommon.

Vital Statistics

The population according to the census of 1921 was 41,002,696, of which Hindus comprised 36,687,777, Mohammedans 2,831,361, native Christians 1,312,060, and other classes 171,498. The percentages of each to the whole are Hindus 89.48 per cent., Mohammedans 6.95 per cent., native Christians 3.2 per cent. and other classes 0.04 per cent. Censuses have been taken every ten years since 1871, and with the figures for these a population growth curve has been prepared. (Fig. 1.) While it is not possible to fit this curve very accurately with such a small number of observations, yet it probably is reasonable to assume

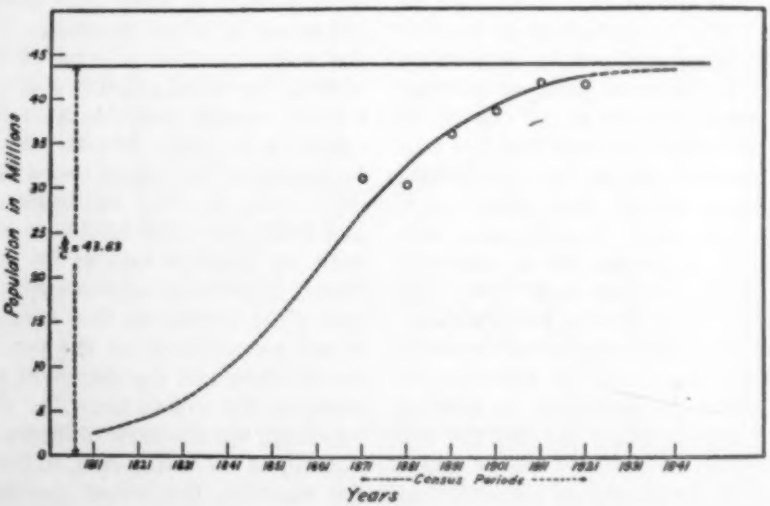

Fig. 1

that the curve shows South India to have very nearly reached an asymptotic population under present conditions. As a matter of fact, it has been necessary during the last few years to import considerable quantities of grain stuffs to meet the needs of the population, and it would appear that in spite of the devastating famine years of 1877–78 and the more terrible influenza epidemic of 1918–19 the population is still too large for the land available with the present futile methods of cultivation. The sociologist might therefore speculate as to the justification for expenditure on public health and prevention of disease, when children and adults saved in one year are apt to be hurled into Nirvana the next by some factor like an epidemic demanded by the inexorable and irresistible pressure of the equation $y = \frac{be^{-ax}}{1+ce^{ax}}$! It is worth while drawing attention in this connection to the decreases of population registered at the censuses following the two calamities already mentioned.

Births

The registered birth-rate during 1922 was 30.0 per 1,000, but it is fairly certain that the actual rate is as high as 42.5 per 1,000. Registration in municipal towns is carried out by paid registrars, but, in the rural areas, which comprise a total population of nearly 36 millions as compared with the five millions of townspeople, registration is done by the village officer. This official post, although not a very lucrative one, carries with it a certain status, and still commands respect, although it can not be obtained by ability to pass examinations but descends from father to son as a hereditary function. As, however, the village officer is primarily a revenue official, it may be imagined that the registration of vital statistics has to take a back seat in the theater of his activities. In Madras City, where registration is more or less accurately performed, the birth-rate for 1922 was 41.2. The highest rates are usually met with in Mohammedan communities. During 1922, out of a total of 215 towns, 13 registered a birth-rate of 40 to 50 per 1,000, and six returned the amazingly high rate of over 50 per 1,000.

Deaths

The registered death-rate for 1922 was only 21 per 1,000, but the actual rate was probably in the vicinity of 33 to 36 per 1,000, although the margin of error is not so great as in the case of the birth-rate. The Mohammedan community again returns the highest rate, as they are, generally speaking, a backward people and entirely governed by tradition. In Madras City the death-rate in 1922 was 43.1 per 1,000, whilst in another town, owing to a severe outbreak of plague, the rate was as high as 70 per 1,000. Infantile mortality is very high all over the Presidency, although examination of the registered rates since 1901 shows that there has been a distinct downward tendency during the last 22 years. This fact is of some importance, as a few enthusiasts of the newly fledged child welfare schemes have claimed the reduction in infant mortality to be entirely due to their efforts. Whilst admitting the value of such welfare work, it seems equally desirable to avoid undue optimism as to the results yet obtained. In several of the largest towns the infant death-rates in 1922 ran between 311.6 and 352.8 per 1,000 births, as compared with the English rate of 80 per 1,000. Nearly 50 per cent. of these infant deaths took place during the first month of life, a sad commentary on the condition of the mothers and the degree of skill possessed by the Indian midwife. Generally speaking, the death-rates increase as one goes down the social scale, and although, for example, the infant mortality rate

among Hindus in Madras City taken as a whole is about 300 per 1,000 births, yet the death-rate among Brahman babies is little over 100 per 1,000 births and is nearly as low as that of the European community. As regards maternal deaths, in the towns 13.7 mothers die per 1,000 births, and the rate for the whole Presidency is probably much higher. Indian women, during parturition, are cursed with the attentions of attendants known as "barber" midwives, whose ignorance of antiseptics and their use is as colossal as their courage in tackling emergencies with the aid of collections of the most fearsome and medieval weapons; and every medical man in India is only too well acquainted with the victims of their prowess, brought as they are to hospital in the last stages of septic poisoning. The prejudices of even the better educated Indians are almost impossible to overcome, and an example can be given of an educated lawyer, the chairman of a municipality, who had been persuaded to engage a trained midwife for his town, but who declined to employ her skilled services in preference to the barber-woman when his own daughter was about to present him with his first grandchild.

Vital Index

For the whole population the vital index (=100 births/deaths) in 1922 was 143.3, that for the Hindus being 142.4, for the Mohammedans 151.9 and for Indian Christians 150.8. Comparing the

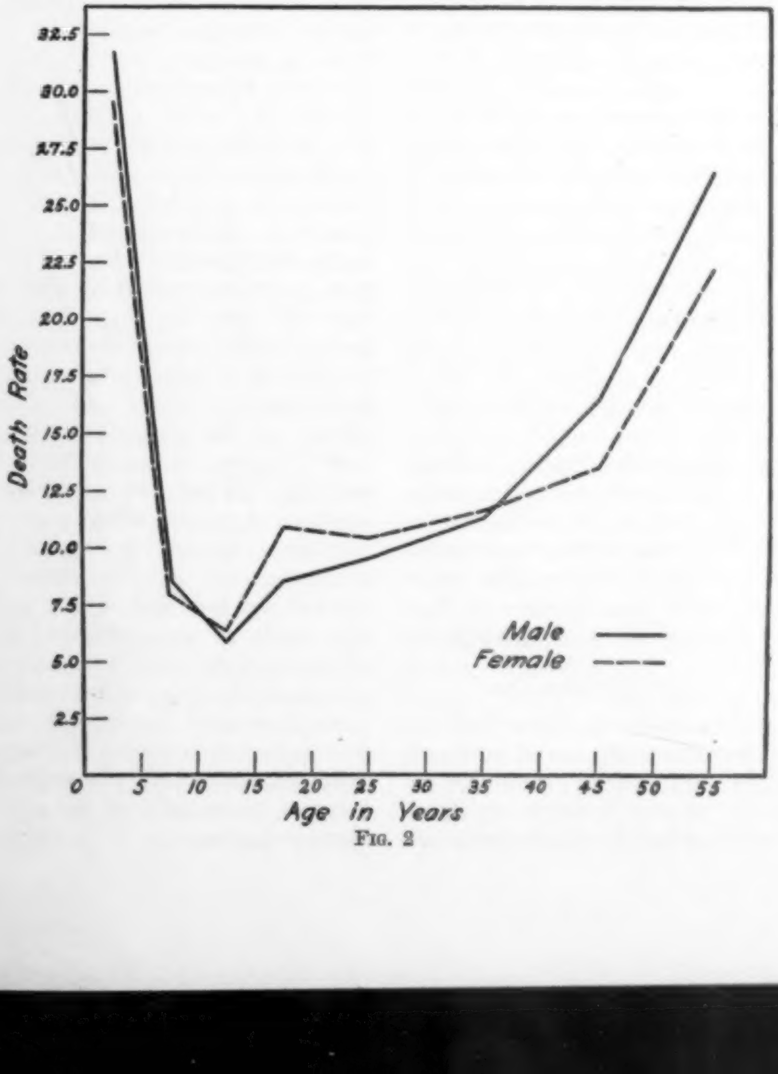

Fig. 2

urban population with the rural, the vital index for the former during 1922 was 122.6, and for the latter 147.6. For Madras City the corresponding figure was only 95.6, in spite of the constant immigration of young adults into the town; and for some of the other large towns the index was also under 100. City life in the Orient is therefore even more fatal to the population than it is in Occidental countries.

A graph showing the specific death-rate curves for males and females during 1922 has been prepared in a very approximate fashion, but it shows the salient points fairly clearly. (Fig. 2.) The most striking feature is the extraordinary hump in the female curve at the age-period 15 to 20 years, and continuing to lesser degree into the period 20 to 30 years. This peculiarity is almost wholly due to maternal deaths, for it is by no means uncommon for girls to be mothers by the age of 13 to 15 years. Calculated on the total female population in the age-periods from 15 to 40 years, the excess death-rate represents approximately 20,000 deaths. To put it in another way, the ratio of deaths in females to every 100 male deaths in the population at different ages is as follows:

	5 to 10	10 to 15	15 to 20	20 to 30
Madras	100	100	117	116
Punjab	113	138	133	125

The figures for the Punjab indicate that the Madras rates are by no means the highest to be met with in India.

For the whole population, the approximate mean duration of life is 27.6 years, as compared with over 45 years in England and Wales in the period 1901–1910.

Chief Diseases

The registrars have instructions to register all deaths under one of the heads referred to in the table, with the exception of "injuries," which are classified into (1) suicides, (2) wounds and accidents, (3) snakebites and death by wild beasts, and (4) rabies; and "childbirth deaths." It is hardly necessary to explain that further differentiation would simply defeat the end in view. Even as it is, many of the village officers make up their registers only once a month, when a return is required, and they allow their imaginations to run riot, or to lie absolutely dormant, when they come to fill in the column of "causes of death." In one district where malaria was the commonest disease, more than 95 per cent. of the deaths were being registered as "fevers." Investigation of 399 deaths in the area showed that only 117 of these were really due to one or other form of fever; 75 were due to pneumonia, consumption and other respiratory diseases—all having fever as a symptom; 50 were due to dysentery and diarrhoea—which may be accompaniments of malaria; 21 were maternal deaths—which certainly all had fever; 4 were due to smallpox, a disease which every attempt is made to conceal; 4 were deaths from accidents such as drowning; 14 were cases of beri-beri and dropsy, and 3 were the result of rheumatism. A village officer, on being asked for an explanation of this carelessness, naïvely replied that it was "*mamool,*" or custom, to register deaths as due to fever, and any one acquainted with India will appreciate the force of "mamool" on the mind of the average Indian.

Chief Diseases

	Deaths in 1922	Deaths in 1921
Cholera	16,502	27,064
Smallpox	22,801	9,792
Plague	9,193	11,875
Fevers	319,688	316,019
Respiratory diseases	48,166	45,180
Dysentery and diarrhoea	51,805	53,621
Other causes	391,081	363,346
Total	859,236	826,897

Table II

Cholera

This disease is endemic in India and is one of the greatest scourges of the country. Recent research has shown that the disease not only shows a yearly periodicity, but that in Madras Presidency, at least, there is a definite six-yearly periodic wave. As the usual water supply for the Indian village community is a shallow well, it is not easy to prevent the spread of cholera infection; but chlorination of the wells has given promising results. The villager, however, often resents the introduction of such things as chlorine or potassium permanganate into his water supply, and the sanitary inspector who attempts to do so occasionally finds himself in trouble.

Smallpox

This is another disease which is always to be met with. During 1922, 7,690 deaths from smallpox occurred among infants under one year of age, 8,476 between the ages of one and ten years, and 6,635 above 10 years. Smallpox is therefore still a disease of young children in Madras. The chief reason for this is that the benign British Government has refrained, unlike the more ruthless but more efficient administration in Germany, from enforcing compulsory vaccination on an unwilling but ignorant people. Madras, however, possesses a Vaccine Institute which issues over two million doses of lymph annually. The vaccine is sent out by post, but as it very often takes 5 to 7 days to reach its destination and as the temperature is frequently above 100° F. in the shade, it is difficult to ensure the potency of the lymph by the time it comes to be used. For the same reason, the manufacture of lymph is entirely suspended during the hot weather months, and no vaccination operations are performed during the four hottest months. When this plan was introduced, there was a very considerable reduction in the number of vaccination operations performed, but a corresponding rise in the success rate resulted, which for all practical purposes gave the same number of protected persons, whilst also reducing enormously the labor and cost involved in carrying out thousands of unsuccessful operations. In the more remote districts the cost per vaccination operation may be as much as 50 cents.

Plague

Bubonic plague has been endemic in India since 1896, but in Madras Presidency it has been confined to only seven or eight of the 26 districts which go to make up the province. Occasionally a sporadic outburst of the more fatal pneumonic type of the disease occurs, but these have fortunately never spread beyond a few families at any one time, and there has been no experience of this type of plague corresponding to the epidemics in Korea and North China. The two chief preventive measures adopted are inoculation and evacuation of infected houses. It can be realized that it is by no means easy to evacuate a town of any size, although the fear of plague is now engrained into the Indian and he does not usually raise as much objection as he does to inoculation, owing to the general belief that the latter causes sterility. The plague regulations, issued under the epidemic diseases act, give wide powers to the authorities, who can insist that any one objecting to leave his house shall submit himself and his family to inoculation with anti-plague vaccine. In one badly infected district in 1922 over 95 per cent. of the total population in the affected area were inoculated, but this was an exceptionally successful effort. In one family a man and his wife and children were all inoculated, with the exception of the eldest son, and no powers of persuasion were of any avail in getting permission to protect the boy. Two weeks later infected rats were found

in the house, and the only member of the family who became infected was the uninoculated boy, who eventually died of the disease. A curious fact worth mentioning in this connection is that the Plague Research Commission has found that the best rats for experimental purposes are the rats of Madras City, as these animals are the most susceptible of any Indian rat obtainable. Yet, plague has never managed to retain a foothold in Madras, although sporadic cases have been introduced on many occasions. It is certain that we do not yet know all about the epidemiology of plague in India.

Fevers

Malaria is the predominant fever and almost entirely masks such diseases as typhoid fever and tuberculosis. Typhoid fever seems to be increasing, the figures for the Madras General Hospital being 79 cases in 1910, 706 in 1920 and 564 in 1922, although this may be partly explained by better diagnosis. As regards tuberculosis it was commonly said not to exist in India about twenty years ago, but it is now widespread and a recent estimate puts the figure for Madras City as high as 40,000 cases. A violent epidemic of relapsing fever broke out in Southern India in 1920, and has spread all over the Presidency within the last three years. The disease was entirely confined to the lower classes, and even where caste Brahmans lived in a street surrounded by non-caste people, the houses of the two being only a few feet apart, the communistic segregation practiced by the Brahman acted as a perfect safeguard against infection which was carried by the louse, ubiquitous among the pariahs. Relapsing fever had not been known in South India for over 100 years, and it is tolerably certain that the infection was brought in by troops and followers returning from Mesopotomia and East Africa. Other fevers, such as dengue, 3-day and 7-day fevers, are all very common.

Dysentery and Diarrhoea

Dysentery takes a large toll yearly in Southern India, the disease being mostly bacillary in type. The death-rate in Madras City for 1922 from this cause was 8.0 per 1,000, and in urban areas it varies between 3.0 and 6.5 per 1,000. For statistical purposes, diarrhoea deaths are classed along with those from dysentery, as many of the diarrhoeas are known to be dysenteric in origin. With the decrease which has occurred in cholera during the last six years there has been a corresponding decrease in the number of deaths registered under the term "dysentery and diarrhoea." It is probable that this is due not only to the greater prevalence of diarrhoeal complaints during a cholera epidemic but also to the concealment of cholera cases in order to avoid the worry caused by the visits of officials of the Public Health Department.

Rabies

Rabies is commonly spread by rabid jackals and hyenas. During 1922, 220 deaths from this cause were registered, but doubtless this is an under-estimate. The Pasteur Institute now dispatches the vaccine to all headquarter hospitals on indent, but this method of treatment is open to objection as it is difficult to keep trace of the individual if he chooses not to return before his course of injections is completed.

Ankylostomiasis

Hookworm infection ranges about 100 per cent. in a number of the wet districts of the Presidency, but Dr. Kendrick, of the Rockefeller Foundation, who spent three years in South India, found that in no district was the infection rate under 30 per cent. A survey of the students in the Madras Medical College showed that even in this class of the population the infection rate was from 65 to 84 per cent. In so far as the Rockefeller Foundation plays the part

of a health propaganda agency it has a very important work in hand; but most people will agree that a dozen Rockefeller Foundations could not eradicate the hookworm from the tropics, until the people themselves give evidence of a real interest in health matters, and of that there is so far little sign.

Deficiency Diseases

Some of the deficiency diseases have already been mentioned, but it is worthy of mention that beri-beri is almost strictly confined to a group of districts in the northeast of the Presidency. In the center of this epidemic area, nearly 8 per cent. of the total deaths during 1922 were said to be due to this cause, but this figure no doubt included all cases presenting dropsy as a symptom.

Leprosy

It is estimated that there are over 20,000 lepers in South India, and only a small percentage of those are cared for in leper asylums. The Government of Madras has recently founded a large leper colony, which is to be managed by European missionaries.

Kala-Azar

This puzzling disease finds an endemic home in parts of Madras City and in some of the eastern coast districts. It has never been the serious problem that it has proved to be in Assam.

Public Health Organization

The portfolio of medicine and public health is held by an Indian minister under the Reforms Act of 1919, in which year a number of subjects were transferred to Indian administration. A public health board acts as an advisory body to the minister, and all large schemes, such as water supplies, drainage and sewage works, come before this body for final approval. The public health department proper consists of a director of public health and six assistant directors, while for each of the 26 districts a fully trained health officer is in charge of health activities. Seventy-five per cent. of the salaries of these health officers is paid by the Madras Government, the balance being met from district board funds. In addition, 12 to 14 of the larger towns have full-time health officers of their own. The government also maintains a body of 162 trained sanitary inspectors, 8 to 12 working in each district under the jurisdiction of the district health officer, and a number of trained sanitary inspectors are employed in every municipality. Vaccinators trained in the Institute of Preventive Medicine are maintained by municipal councils and district boards, while registrars of births and deaths are attached to all municipal health staffs. The total municipal expenditure on public health during 1922 amounted to 23.5 lakhs, or about $800,000. The corresponding expenditure of local boards was 10 lakhs or about $340,000, whilst government expenditure on public health amounted to 30 lakhs or about $1,000,000. The total cost works out at nearly 1.3 annas, or about 2 cents, per head of the population. Before making any invidious comparison of this figure with those of other countries, it must be remembered that India is a poor country, the total budget of the Government of India being only something like five million pounds sterling, or less than $25,000,000.

For the furtherance of public health in the Presidency, a Madras Health Council has recently been inaugurated. Its chief function is the distribution of health propaganda literature and illustrated health lectures, and from its first annual report, which has just been published, it is obvious that the council has met an urgent need. The Madras Maternity and Child Welfare Association has

18 centers in Madras City, and also 15 to 20 others in different towns in the Presidency. The Ankylostomiasis Bureau, staffed by the Rockefeller Foundation, acts as an additional agency for the spreading of knowledge of hygiene and public health. It is to be remembered that every leaflet, every poster and every lantern slide and lecture must be prepared in four to six different vernacular languages if they are to be fully effective, and this adds enormously to the cost of a propaganda campaign.

Finally, as regards legislative measures dealing with public health, either partly or wholly, these constitute quite a formidable list. The "Madras City Municipal Act" applies only to that city, the corresponding measure for other towns being the "District Municipalities Act," while for rural areas the "Local Boards Act" includes a number of sections on public health. Additional measures are the "Village Panchayat Act," the "Town Planning Act," the "Indian Factories Act," the "Registration of Births and Deaths Act," the "Town Nuisances Act," the "Epidemic Diseases Act," the "Foods and Drugs Act" (for prevention of adulteration), and the "Indian Ports Amendment Act," which deals with port sanitation and marine quarantine. Most of these acts are local acts passed by the Madras Legislative Council, but the "Epidemic Diseases Act" and the "Indian Ports Act" are Imperial, and apply equally to the whole of India.

Under the municipal and local boards acts a volume of model by-laws has recently been prepared and issued by the government for the guidance of bodies concerned in local self-government. The health officers employed in Madras are trained in the medical college and must possess the degree of "Bachelor of Sanitary Science" of Madras University before they are confirmed in their appointments. This degree is based on the regulations in force for the "Diploma in Public Health" of British universities. All sanitary inspectors are also trained in the medical college, where they undergo one year's course in various subjects preparatory to taking a government examination for the "Sanitary Inspectors' Certificate." Every five years each sanitary inspector is required to take a refresher course and pass a further examination.

Certain individuals, ignorant of local conditions, are apt to be hypercritical of British administration in India, because of the apparently slow advance made in such fields as that of public health, but it must be fairly obvious to the unbiased mind that a sound organization is in existence, in Southern India at least, and it remains to be seen whether further progress will be made now that the helm of the Ship of State is passing into the hands of Indians themselves.

THE PRESENT STATUS OF THE THEORY OF RELATIVITY[1]

By Dr. PAUL R. HEYL
BUREAU OF STANDARDS

In the realm of science, as well as in that of sport and adventure, there is to be found the excitement that arises from the unexpected. The present status of the theory of relativity is a case in point. In its unexpected advent and its rapid rise to first magnitude it suggested a new star; but it has been no longer ago than the Toronto meeting of the British Association in 1924 that the opinion was expressed by a leading authority that relativity had reached its maximum, had "struck twelve" and become barren. Many of us can remember a similar feeling of pessimism regarding physics in general which possessed the minds of scientific men for several years just prior to the discovery of the X-rays. It was widely held that the great discoveries in physics had all been made, at any rate, all that were possible, and that future progress would concern itself with second order effects and "one more decimal place."

There was much, indeed, to warrant the opinion that the theory of relativity had achieved the status of a classic and was henceforth to be comfortably shelved alongside the Principia; yet while these opinions were being expressed, experiments were under way which, when announced in the spring of 1925, injected new life into the theory of relativity and created a situation of which the end is not in sight. We refer, of course, to the repetition by D. C. Miller of the historic Michelson-Morley experiment on the top of Mt. Wilson and his announcement of a definitely positive result.

It has perhaps been rather generally supposed that the theory of relativity arose from a negligibly small result obtained when this experiment was originally performed by Michelson and Morley in the attempt to find evidence of the supposed motion of the earth relative to the ether. This is only part of the truth. There were other experiments, all to the same purpose and all yielding negative results. It was the cumulative testimony of all these which led Einstein to formulate his theory of relativity.

Such an experiment was that performed by Trouton and Noble,[2] first suggested by Fitzgerald.[3] It appears from theoretical considerations that a condenser, suspended by a fine filament with its plates inclined to the direction of the ether-drift should, upon being charged, experience a torque. Trouton and Noble tried this experiment, obtaining a negative result.

Another experiment of this kind aimed at the detection of double refraction produced in a transparent body on account of ether-drift through it. It is a natural conclusion that if the ether be streaming through a block of glass in a certain direction the speed of light in this direction will be different from that at right angles to it. The block of glass for this reason should become doubly refracting. Experiments of this nature

[1] Published by permission of the director of the National Bureau of Standards of the U. S. Department of Commerce.

[2] Phil. Trans. A, Vol. 202, p. 165, 1903.

[3] Scientific writings of G. F. Fitzgerald, p. 557.

were performed by Rayleigh[4] and by Brace[5] with negative results.

These experiments are so simple in theory and parallel so closely the well-known work of Fizeau on the speed of light in moving water (which, however, gave a positive result) that they are worthy of careful study. If there is any such thing as ether-drift in a transparent body it would appear impossible to have an optically isotropic body at all, unless its natural double refraction happened to be equal and opposite to that produced by ether-drift; and this could be discovered by observations made in different orientations of the whole apparatus with respect to the earth's motion in space.

These various lines of experiment were known to Einstein, and his special theory of relativity was a generalization resulting from a view of the entire field of evidence. For some reason, however, it appears that the Michelson-Morley experiment has, in the minds of many, gradually come to be credited with the sole responsibility for the origin of the theory of relativity, and the recent announcement by Professor Miller has, perhaps, created a rather general impression that "relativity is dead."

But before we can come to such a conclusion it will be necessary to see what results will be furnished by the other foundation experiments of relativity, the Trouton-Noble and the Rayleigh-Brace experiments when performed at a considerable altitude. Attention was called to this necessity in a note[6] published shortly after Miller's first public announcement.

It is with special interest, therefore, that we learn that Professor Tomaschek, of Heidelberg, has repeated the Trouton-Noble experiment on the Jungfrau, at an altitude twice that of Mt. Wilson, with a negative result.[7]

[4] *Phil. Mag.*, December, 1902, p. 678.

[5] *Phil. Mag.*, April, 1904, p. 317.

[6] Heyl, "The Ether Drift," *Science*, May 15, 1925.

[7] Annalen der Physik, No. 24, 1925, p. 743.

Tomaschek has done more than merely to repeat the experiment as Trouton and Noble carried it out. He has executed a variation upon it by searching for the production of the magnetic field which should be produced in the neighborhood of a charged condenser moving with a velocity relative to the surrounding ether. This variation has one great advantage: the effect it deals with is of the first order, while that of the original Trouton-Noble experiment (and also the Michelson-Morley experiment) is of the second order.

Tomaschek's experiment appears to have been most carefully executed, yet attention may be directed to one point. It has been shown by Kennard[8] that the theory of the Trouton-Noble experiment, as originally carried out with a mica condenser, is still somewhat uncertain. Kennard advised future experimenters to use an air condenser, the theory of which is satisfactory. Now it appears that in Tomaschek's repetition of the Trouton-Noble experiment a mica condenser was used.

Fortunately, however, in the variation of this experiment carried out by Tomaschek an air condenser was used for some of the experiments. In others, a dielectric of sulphur was employed which, being a crystalline body, Kennard would regard as unsuitable.

Tomaschek's closing discussion is admirably judicial. He recognizes the conflict between his result and that of Miller, and points out the advisability of a repetition of one of the experiments at the same place in which the other was performed. To this may be added the obvious suggestion that it would be an additional source of security and satisfaction to have these experiments carried out by independent observers, provided it is possible to obtain such equally as skilled as Tomaschek and Miller.

In the new interest now attaching to the special theory of relativity the ex-

[8] Bulletin of the National Research Council, No. 24, Vol. 4, part 6, December, 1922.

periments of Rayleigh and Brace should not be overlooked. Their theory is very simple, and the necessary instrumental outfit ought not to be incapable of being so constructed that it may be carried up in an airplane.

We have made as yet no reference to the three experimental tests of relativity suggested originally by Einstein, for the reason that none of them refers to the special theory of relativity, which is the aspect of the situation now brought anew into question by the results of Tomaschek and Miller. Einstein's three tests are concerned with the general theory of relativity, or, more specifically, with Einstein's theory of gravitation. It is to be remembered that the general theory of relativity is founded upon a postulate not involved in the special theory—the equivalence of gravitation and inertia—and that if the special theory were to be finally discredited this principle of equivalence would remain unshaken.

It is therefore a source of satisfaction to turn from the contradictory and confusing evidence in the case of the special theory of relativity and find that the evidence for Einstein's theory of gravitation is consistent throughout.

Three tests for this theory were originally suggested by Einstein: the irregularity in the motion of the planet Mercury; a deflection of light rays passing near the sun; and a shift of the Fraunhofer lines in the solar spectrum.

Of these three the first was the earliest to establish itself, albeit not without opposition. There were not lacking attempts to explain this anomalous motion by postulating the existence of attracting matter between Mercury and the sun, but the difficulty was to account for the disturbance of Mercury without interfering with the motion of Venus. The seriousness with which the anomalous motion of Mercury has been generally regarded and the impossibility of accounting for it by the law of gravitation are shown by the fact that at one time the radical proposal was made to alter slightly the Newtonian formula by changing the exponent 2 to 2.000 000 1612. This was first suggested by the elder Asaph Hall, the discoverer of the satellites of Mars, and was for a time regarded favorably by no less an authority than Newcomb, who abandoned it only after E. W. Brown showed that the motion of the moon did not allow of even this slight departure from the number 2. But with the ease and grace of a master, Einstein shows how it is possible to account for the irregularity of Mercury without altering the relations between the earth and the moon, or disturbing the motion of Venus or any other planet. In default of any other theory, the relativistic explanation of the motion of Mercury has attained an acceptance which, though perhaps provisional, is general.

In his second and third proposed tests Einstein ventured upon dangerous ground—that of prediction. Here it was no longer a question of explaining a known fact, but of predicting something which had not yet been observed or even suspected. The success of such a prediction has always been regarded as a weighty argument for the theory in question; for example, Poisson's prediction of the existence of a bright central spot in the shadow of a circular disc did much to establish the undulatory theory of light.

For the experimental confirmation of the second test, the deflection of a light ray grazing the sun's surface, it was necessary to wait for a total eclipse. Two such opportunities presented themselves within a reasonable time, and finally (largely as a result of the Lick Observatory expedition to observe the eclipse of 1922) Einstein's prediction was accurately confirmed.

The third test has been much more difficult to confirm than either of the first

two, because of its small magnitude. The shift of the solar lines predicted by Einstein is an amount so small as to be difficult to detect in the presence of other displacements which have long been recognized and understood. Contradictory results were announced by several observers, and much uncertainty existed until Adams, of the Mt. Wilson Observatory, succeeded in the difficult task of photographing the spectrum of the faint companion of Sirius. The advantage of using the spectrum of this star rather than that of the sun is the vastly greater gravitative field obtainable, and the consequent multiplication of the Einstein shift.

The companion of Sirius is one of the most remarkable stars in the heavens. It was discovered in 1862 by Alvan G. Clark, while testing a telescopic objective. It is a very faint star, of about one ten thousandth the brightness of Sirius. Its mass is about equal to that of our sun. Its spectrum is of such a nature as to indicate a surface temperature of about 8,000°; that of the sun is 6,000°. Its brightness per unit surface must therefore be greater than that of the sun, though the total light it emits is considerably less. It must in consequence have a smaller surface (and diameter) than the sun, though equal to it in mass; in other words, it must be of a much greater density.

Upon calculation, its density comes out so high as to appear at first sight preposterous. Eddington[9] finds it to be about 50,000.

That a body of such unheard-of density can obey the gas laws is at first sight impossible; yet Eddington offers the ingenious and plausible suggestion that the atoms of the star, at the very high temperatures prevailing in its interior, may have their electrons knocked off, leaving the nuclei only, which, deprived of their "crinoline" (as Sir Alfred Ewing calls it), may pack far more closely than before and yet be sufficiently distant to correspond to a gaseous structure.

At the surface of a star of this density and of a mass equal to that of our sun, the solar Einstein shift would be multiplied some thirty-fold, placing it well within experimental recognition. The shift actually found by Adams is within ten per cent. of that calculated by Eddington.

Considering the approximate nature of Eddington's calculated value of the density, this is a confirmation of the third Einstein test that is entirely satisfactory.

A fourth experiment, proposed to test the fundamental postulate of Einstein's gravitational theory, was carried out a few years ago at the Bureau of Standards.[10] This theory is, as has been said, based upon the assumption of the identity of gravitation and inertia.[11] A delicate test of this postulate is possible with a crystal of one of the non-isometric systems, for in such a crystal every known physical property (save inertia and, possibly, weight) varies with the axial direction in the crystal. The speed of light in such a crystal is different in the different axial directions, making the crystal doubly refracting; the conductivity for heat and for electricity vary similarly; the coefficient of expansion, the elastic modulus, the selective absorption for light, the pyro-electric and piezo-electric properties (when present), and even the hardness of the different faces all vary with the axial di-

[9] Monthly Notices, Roy. Ast. Soc., March, 1924, p. 322.

[10] "Scientific Papers of the Bureau of Standards," No. 482, February 16, 1924; "Gravitational Anisotropy in Crystals," Heyl.

[11] Heyl, "The Common Sense of the Theory of Relativity," SCIENTIFIC MONTHLY, December, 1923.

rection involved. It is therefore an interesting question whether in such a crystal gravitation will behave as do the overwhelming majority of physical properties, or whether it will align itself with inertia, standing alone on the other side.

The possibility that crystals may display gravitational anisotropy has not gone unrecognized. All previous experimental work on the subject, however, antedates Einstein, and the results were uniformly negative. No great degree of precision was reached, the highest being that of Poynting and Gray,[12] one part in 16,000, not at all an adequate answer for a question of this importance. Moreover, all such work was confined to crystals of the hexagonal system.

The experiments at the Bureau of Standards were planned to include specimens of all non-isometric crystal systems, and to reach as high a precision as possible. The method was that of direct comparison of weights in different orientations of the crystals with respect to the earth. The precision reached was one part in a billion (10^9) and to this degree no difference in weight was observable.

A fifth experiment, suggested by Silberstein[13] and executed by Michelson, is of interest in this connection. It was based upon the possibility of the rotation of the earth having an effect upon the speed of light. If the ether rotates with the earth there can be no acceleration or retardation of a beam of light traveling in any direction on the earth's surface; but if there is any differential motion between the earth and the ether it should be possible to show it by sending two beams of light in opposite directions around a closed circuit, and looking for a shift of interference fringes. Silberstein also calculated from the general relativity theory, without any reference to an ether, that a shift of interference fringes should also result, equal in magnitude to the maximum produced by a completely stagnant ether.

Hence, if it should be found that there is either no shift, or a shift less than the maximum, relativity would be wrong. A maximum shift, however, would be ambiguous; either relativity is right, or there is an ether which does not partake at all of the earth's rotation. This ambiguous result was actually that found by Michelson.

This result, while indefinite as far as relativity is concerned, is rather in conflict with the original Michelson-Morley result (at ground level), though it may be said, of course, that ether drag due to rotation and to translation may be two different questions. No reason, however, is apparent for drawing such a distinction.

What, then, is the present experimental status of the theory of relativity?

The evidence in the case of the special theory is conflicting. The experiments of Tomaschek, the original Trouton-Noble experiment (for what it may be worth), the experiments of Rayleigh and Brace, and the original Michelson-Morley experiment (near ground level) all point to the non-existence of ether-drift. It should be noted, however, that Miller emphasizes the point that the original results of the Michelson-Morley experiment were in no case zero, but only a very small fraction of that expected. Miller's later result points to an ether-drift of considerable magnitude, ample enough to be easily detected, it would seem, by any of the other experiments. Further work, involving interchange of stations and variations of observers, is called for.

With the general theory the evidence is entirely concordant, with the exception of one result, which is ambiguous.

[12] Phil. Trans. Roy. Soc., Vol. 192, 1899, p. 245.

[13] *Phil. Mag.*, September, 1924, p. 395.

Additional weight perhaps attaches to the positive results of two of these experiments from the fact that those in charge of the work had no previous bias in Einstein's favor. This was the case with the Lick Observatory eclipse expedition, in charge of Director Campbell, and with the crystal weighing experiments at the Bureau of Standards. The latter work was indeed undertaken by the experimenter in a spirit of definite skepticism regarding Einstein's theory, which appeared (to one who had learned his physics before the discovery of the X-rays) rather too bizarre and fantastic. But the negative result of this work placed the experimenter very much in the same position as that in which Balak, the king of the Moabites, found himself on a certain occasion.

The land of Moab had been invaded by the host of Israel, as the sands of the sea in number. A battle was impending, and Balak was none too certain of the outcome. He felt that he needed moral support and ghostly counsel, and he sent messengers to Balaam the soothsayer, saying: "Come, curse me Jacob; come, defy me Israel!"

It was a professional call, and Balaam came. Balak was glad to see him. He gave him presents; he showed him much honor; he took him up to a high place where he might see the host of Israel encamped on the plain below, and he waited impatiently for the soothsayer to speak.

And Balaam spoke the words which the Lord put into his mouth; but Balak looked at him aghast, and said: "What is this? I called thee to curse mine enemies, and lo! thou hast blessed them altogether!"

RADIO TALKS ON SCIENCE[1]

HUMAN NATURE AND WAR

By Professor GEORGE M. STRATTON
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OF the Four Horsemen described in the Apocalypse, science gives us high hope that at least two can be unhorsed. By our increasing medical knowledge, we are gradually ridding the world of pestilence; and there is reason to believe that science will rid the world of famine. But with regard to war there are many who assert that science offers no hope whatever; that it indeed closes the door against hope and leaves us to despair.

For war, it is said, springs from human nature; and will continue as long as our unchanging human nature lasts.

No statement which claims the authority of science could be of greater importance to the public. It touches national interest and international policy at every point. Psychology could not be of greater service than by helping toward an intelligent decision of so weighty a problem. With your consent and interest, then, let us face this single question steadily. Is it true or is it not true that our increasing knowledge of the human mind shows that human nature will always require nations to settle their disputes by physical violence rather than by law and its more orderly methods? The true answer to this is worth untiring search.

Those who declare that war comes from human nature and that human nature does not change have weighty evidence for their belief. Wars have occurred since the remotest time of human history. Wars doubtless were waged long before human history began. They reach still farther back, into the animal world, where pugnacity is frequent and widespread. Thus all the momentum of our animal and human inheritance would seem to carry us fatally forward along the ways of war. It surely seems that humanity is pugnacious in its very nerve and muscle; that man is born to battle as the sparks fly upward. Human nature through all the ages, it would seem, shows the same qualities, and will prevent change, whatever may be the strong desire for a different order of life.

And yet the thought which I would urge as the word of science is the exact opposite of this. I shall ask you to observe for yourselves profound changes which have occurred in human society and which have not required a shadow of turning in human nature itself—changes quite as profound as would be involved in driving war to the very outskirts of society. Institutions based upon the most permanent traits of human character have been torn down and swept away, and without destroying or even weakening a single one of our great human motives.

II

Would you be willing to go with me, not back to the cave man, but to what has occurred within comparatively recent times—in Mexico, in the islands of the Pacific and in Africa? In these and in other places it was customary to sacrifice living men upon the altar of some powerful supernatural being. To obtain the creatures for such sacrifices was often one of the aims of war. And beyond this, it was thought that the divine wrath could be appeased, not by sacri-

[1] Broadcast from Station WCAP, Washington, D. C., under the auspices of the National Research Council and Science Service and the direction of W. E. Tisdale.

ficing war prisoners only but by sacrificing the life of one's own son or daughter, by thus offering something still more precious to the worshipper and to his god.

We can imagine the opposition to those who in due time wished to do away with this ghastly institution. "What!" others must have said, "Would you change human nature? Do you expect men to give up their very religion? Would you have us refuse to offer to our divinity the most precious things we have?" And yet in spite of such misgivings human sacrifice in all civilized regions has gone forever, and without altering a single one of the deep motives which supported it. There remained unchanged the love of children; indeed this love grew stronger; and there grew stronger also the sense of the value of human life generally. There remained the same awe of the unseen world and the same impulse to avert the wrath of this unseen world. The institution of human sacrifice was destroyed without changing human nature and without destroying either religion or human dedication to the ideal.

And the same is true in another great region of social conduct. Blood vengeance once existed almost the world over—the feeling that the death of a member of one's own family must be avenged by taking a life of the family that caused the death. The impulse to wreak such vengeance has been exceedingly powerful and exceedingly difficult to control. Even so mild a statesman as Confucius felt that an official could not live in the same country with one who had killed a high officer of the state. Confucius felt that any subordinate official must personally see to it that the death of his superior did not remain unavenged.

But there came a time when the spirit of the law spoke with an entirely different voice. It said "No" to this deep and almost irresistible cry that an individual who has been wronged shall himself take the blood of the wrong-doer. "Vengeance is mine," the law came finally to say, "and not yours." "Your impulse is, in a measure, just; but it is a too-crude, a too-expensive way to obtain justice. There will, on the whole, be more of justice if those who are less close to the wrong shall determine who is guilty and what shall be his punishment." Here, again, we may imagine the critics who in that day exclaimed: "Do you expect a man not to burn with indignation at the death of his own kinsman? Is he to accept coolly the killing of his father or of his son? You will first have to change human nature before you can attain your goal." Yet in spite of the seeming inability, the institution of private blood-vengeance has been done away, and without requiring that human nature should change by a hair's breadth. There still remain all the deep motives of revenge. There is in us to-day the same love of family, the same hatred and rage at the taking away of one's own flesh and blood, the same desire to right the wrong done by the violator of the family tie. Personal blood-revenge has given way to communal law without requiring that human nature itself should give way. We simply have instituted better methods of satisfying the ancient human impulses, while leaving the impulses themselves strong and untouched. In the same way one might speak of piracy and of duelling, which also have been virtually abolished while human nature remains unchanged.

But I hasten on to slavery, which comes closer to us and whose abolition is within the memory of men who still live. Slavery's hold upon man is from earliest times. The enslavement of others has marked the leading people of the world. Civilization itself has seemed impossible without it. Only yesterday the living bodies of men and women were bought and sold even in our own land. Its effect is before all our eyes in the mil-

lions of Negroes now everywhere in our country. What deep psychological roots slavery had! It drew its strength from the acquisitive impulse—from the desire for wealth, for property. It drew its strength also from the joy of dominating other human beings; from the satisfaction which comes of leisure with its opportunity for a more generous giving of necessities and of luxuries to one's own family and to one's friends. Slavery was protected by all the intellectual and the emotional defenses of those who owned slaves. It seemed as though the laws of nature, of society and of God not only supported but required this institution; and as though the men who worked to abolish slavery had no acquaintance with the human mind, of what is possible with human nature.

But when the time came for Lincoln to sign the great Proclamation, did he by so much as a jot or tittle have to annul the laws of human nature itself? No. Men continued as before to be avaricious. They still are ready to use other men for their own interests. They still are ready to believe that what they deeply desire is also deeply right. But society has fixed new limits to the ways in which men can gratify their impulses to acquire wealth and to control their fellows and to seek leisure and luxury. No attempt was made to eradicate the old impulses, but only to set bounds within which these impulses might seek their satisfaction. There has been no general repression; indeed, there has been given a larger opportunity than ever before to acquire wealth and to control one's fellows. Even in the restrictions a larger opportunity was offered to the disappointed impulses. But men have been prohibited from buying and selling men as one buys cattle.

III

Now to turn our attention, in closing, again to war. Is it, in its relation to human nature, essentially different from these other forms of social behavior? War unquestionably is one of the modes in which our nature finds expression. Deep, indeed, is its hold upon us. The worst, the best of us, goes into it. Hardly a strand is there of human life that is not woven into its texture. Hardly an interest is there to which war does not minister. The difficulties of restraining it are immense; those who would change our ways with regard to it have no light task. So long is war's history and so deep its roots that all thoughtful men will have at times some touch of despair that there can be success against it.

And yet I feel sure that such despair is not scientifically justified. The thought that success here is not impossible can be held without forgetting or misrepresenting human nature. It can be held without shutting one's eyes to the plain facts of experience and psychology. It may well be true that in all its large outline human nature does not change. And yet our experience shows that this unchanging nature of ours permits important changes in human conduct. Indeed, under the stimulation of social enterprise, human nature not only permits, but *demands profound changes.*

We can not doubt that humanity will keep the great impulses which still lead to war—among which is the love of wealth, the love of adventure, the love of honor, the love of mother country. Yet there can be a growing impatience, a growing abhorrence of satisfying these great impulses by the old and bloody methods. Nor is there in the science of psychology anything to assure us that in this one region no farther advance is possible; to assure us that here men have reached the last limit of their inventiveness; that they can institute no shrewder and more satisfying devices to express their devotion to their own nation's life and to the life of the world.

And if those who respect science ask, "What of those who assert that human nature is always the same?" The reply with the best light of science must be:

"Yes, they are probably right in this. Within wide limits human nature does not change. Yet they are wholly wrong in supposing that for the end we here have in mind it needs to change." Great things have been done, while human nature has remained the same. Our civilization has been rid of human sacrifice in our civil life, of piracy upon the high seas, of slavery in all the leading communities. Every one of these social institutions has had the support of men's permanent passions, of men's deepest impulses. To rid the world of these crooked ways of conduct, it has not been necessary to rid the world of humanity. Nor has it been necessary to wait until all sinners have been changed to saints. It has been necessary merely that men should be socially progressive, inventive, adventurous. Men have had to cooperate with others untiringly to change the old habits of their social life. New ways of justice and law and order have had to be viewed with hospitality, without a too tenacious clinging to the cruder and less effective ways.

Human nature here plays a double rôle. It runs with the hare and hunts with the hounds. It expresses itself by clinging to the old, by reverting to the old; but it expresses itself no less by dissatisfaction with the old, by progress to the new. It has not stood as a wall against improvement. The advance, the untiring search for more effective institutions of justice, for more effective ways of meeting the rival claims of large groups of men—these changes are an utterance of our nature. The deepest forces behind human conduct do not merely oppose civilization; they also press us to be more and more civilized. Human nature resists progress, but in all leading lands it also gains the victory over its own resistance, over its inertia and habit, over its own conservatism. It gives the motives, the human instruments and leaders, the intelligence, the insistent urging, which in the past have enriched and strengthened our civil life. And these same great forces, psychology in no wise forbids us to hope, will bring nations to establish better institutions than war to do the work of war.

MAKING AIRSHIPS SAFE

By Dr. L. B. TUCKERMAN

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The successful polar flights of Byrd in an airplane and of Amundsen in the airship *Norge* are still fresh in our minds. We realize more fully than ever before that the airways of the earth are open, though all other ways are closed. The contrast between these two flights and also Amundsen's partially successful airplane flight of last year show again that for a full mastery of the air both airships and airplanes are necessary, each in its own particular field.

In providing for the future development of aviation in the Navy this fact was recognized. The bill passed recently by the House of Representatives, which is now before the Senate for its consideration, authorizes the construction of two new airships, each of six million cubic feet capacity. These are to be rigid airships, similar in construction to the *Shenandoah* and *Los Angeles*. In view of the probability of the construction of these ships, it seems worth while to discuss some of the provisions made to insure their safety. The Bureau of Standards is by law commissioned to assist the United States Navy and other government departments in their scientific and technical problems. The United States Navy has consistently made the fullest use possible of the facilities af-

forded by the Bureau of Standards and many lines of investigation connected with the safety of airships have been in the past and will be in the future carried out at the Bureau of Standards. The work at the Bureau of Standards is, of course, only a part of the technical investigations which are carried out for the purpose of designing safe airships. Both the U. S. Navy and U. S. Army maintain their own investigational laboratories; the National Advisory Committee for Aeronautics also contributes its share and more particularly serves as a directing agency to coordinate all work of this kind in all branches of the government service. My talk this evening, however, will be confined to the work of the Bureau of Standards, with which I am most familiar.

Safety is a relative term. We make houses safe, and our larger cities have building codes in which are written the lessons learned from years of experience of house building; but nevertheless houses fall. We need merely to remember the earthquakes of Tokyo in Japan and of Santa Barbara in California, the volcanic eruptions of Vesuvius and Mount Pelée or the tornadoes which devastated the cities of Omaha and, more recently, Lorain, to realize that houses can not be made absolutely safe against the gigantic forces of destruction which at times rage on the surface of the earth. No construction of the hand of man is absolutely safe.

For over five thousand years men have sailed the sea in ships and five thousand years of training in seamanship lie behind the safety of our present-day maritime traffic. Two thousand years ago Horace said, "Oak and triple bronze armored the heart of the man who first entrusted a frail bark to the ruthless sea"; and to-day, although we know that our ships are safe, as safe as human skill can make them, still in our litanies we have the prayers "for those in peril on the sea." Fourteen years have passed, but the memory of the *Titanic* is still with us. The loss of over fifteen hundred lives in that one disaster teaches us that these prayers are not mere empty forms. The dream of "a goodly vessel that shall laugh at all disaster and with storm and whirlwind wrestle" is still a dream of the future. None the less do men go down to the sea in ships and each year the toll of life decreases.

For thousands of years man has looked upon the birds of the air and dreamed of the time when he, too, would fly, yet it is but a little over a century and a half since man first took to the air, in the balloons of Montgolfier and Charles. It is a scant quarter of a century since navigation of the air became a reality. There has not yet been time for him to learn all the dangers of the air nor for his skill to defeat them. Much already has been accomplished. In the years before the war the German Zeppelins carried over forty-two thousand passengers in more than two thousand flights, and after the Armistice one airship, the *Bodensee,* carried twenty-five hundred more passengers without a single injury to passengers or crew. Much more, however, remains to be done. The loss of the *R-38,* the *Roma* and finally the *Shenandoah* warns us against overconfidence. Even the Polar flight of the *Norge,* dramatically successful though it was, shows again that only through navigating the air can we learn to make air navigation safe. The danger to airships from ice was learned only by actual flight, and the flight of the *Norge* teaches us that this danger must be considered even more carefully in the future. If, after ten thousand years of building houses and five thousand years of sailing in ships, human lives still are lost in the destruction of these works of man by the forces of nature, we must expect as the price of our conquest of the air a toll of human lives. It is the task of every one connected with the development of airships, physicist, chemist, materials engineer, designer, constructor, navigator, to make that toll as small as possible. All

the resources of science and engineering and the accumulated experience of years in building structures, in navigating ships of the sea, and the still scanty, yet valuable, experience in navigating ships of the air must be brought to bear upon this problem.

So many factors enter into the safety of an airship that in the portion of the problem assigned to the Bureau of Standards nearly every line of activity of the bureau is asked to contribute its share. First, the airship must be built of light, but sound and lasting materials, in particular its rigid framework. For this reason, the Bureau of Standards studies in its metallurgical division and engineering mechanics section the properties of duralumin, how it is affected by heat treatment and working, how well it resists the corrosive influence of the atmosphere. Duralumin (the aluminum alloy of which the *Shenandoah* and *Los Angeles* were built) is to-day, when unprotected, more resistant to atmospheric corrosion, or rusting, than unprotected structural steel, but the investigations of the Bureau of Standards promise to furnish means of making it even more durable. Of these sound materials, strong and light girders must be built. So light that a man can carry one of them in his hand and yet so strong that they will carry loads of thousands of pounds. Not yet do we know how light these girders may be constructed and still be safe, but the safety of the ship is insured by testing each of its main girders in our testing machines so that we know its strength is greater than the strength for which it was designed. For the *Shenandoah* nearly 150 full-sized girders were tested and a similar and larger program is planned for these newer ships.

The lifting of the airship is due to the helium gas confined in the gas cells. The securing of gas cells, light and strong and impermeable, is necessary to the safety of the ship. The strength and the permeability of the gas cells are tested by the textile section and the gas section of the Bureau of Standards, and an active investigation is being carried on to secure even stronger, lighter and more impermeable cells.

The problems of design are the problems of the Bureau of Aeronautics of the Navy Department, but so important is the design of such a ship that they call in consultation qualified men from other government departments to advise them on their problems, and part of the work of the engineers of the Bureau of Standards is to assist them in securing the best and safest designs.

Each ship, when built, becomes a school and though the ships to be constructed will represent the best that can be produced with our present knowledge, in the future airships will be still better. Part of the problem is to study the behavior of these airships in flight so that from it lessons may be learned that will make possible these greater improvements in the future.

The electrical division of the Bureau of Standards has developed an electric elemeter already in use on the *Los Angeles* and to be used in future ships. With these instruments the stresses set up in the structure of the ship in flight will be measured. From the measurements it will be possible to learn where, in future ships, lighter construction may be safely used or where alterations in the design may be made advantageously.

When the ship is flown, it is necessary for its safety that the engines which drive it shall be adequate in power and reliability. The problem of a reliable airship engine is not so simple as that of a reliable automobile engine. Two factors enter into the problem which are of less importance for automobiles. In the first place, lightness of construction is essential far more than in any engine which operates on the ground and, in the second place, it is necessary that the engines operate successfully under extremes of temperature and pressure never encountered by an automobile engine. Those of you who have motored

through the Rocky Mountains know that even relatively small heights interfere considerably with the running of a gasoline engine. An airship engine must not only operate satisfactorily at the temperatures and pressures at the surface of the earth but at temperatures often thirty or forty degrees below zero and pressures less than one third the air pressure at the surface of the earth, found at altitudes of thirty thousand to thirty-five thousand feet. The altitude chamber of the Bureau of Standards is a chamber in which engines can be tested under approximately these conditions. Refrigerating machines lower the temperature and large air pumps exhaust the air so that the engines are run under pressures and temperatures corresponding to altitudes of over thirty thousand feet. All the types of airship engines used by the U. S. Navy have been tested in these chambers before being installed.

The navigation of an airship is very much more complicated than the navigation of a ship on the ocean, involving problems in three instead of two dimensions. So important for their safety is the adequate knowledge of the condition of all parts of the ship that many special instruments have been developed for this purpose. The aeronautic instruments section of the Bureau of Standards has contributed many of these: a fabric tension meter to measure the tension of the outer cover; a superheat meter to measure the temperature of the gas in the cells; a gas pressure alarm to tell when the pressure of the gas has reached its safe limit; a gasoline flow meter to insure an accurate control on the fuel consumption of the engines; for control of navigation the earth inductor compass; an air speed meter; an altimeter to show how high the ship is flying; an electric turn meter and a pitching indicator to show how rapidly the ship is turning to the right or left or up and down; a rate-of-climb meter to indicate how rapidly it is rising or falling; a sextant for observation of the position of the sun and the stars, necessarily more complicated than the common sextant used at sea. These are some illustrations; time will not permit of a complete description of these instruments, but a visit to the control cabin of an airship will show how carefully provision is made to insure that all the conditions of the ship which affect its navigation are measured and controlled, by instruments immediately under the eye of the pilot.

It has been possible to mention only briefly a portion of the work which is being done at the Bureau of Standards to insure that the airships our Navy builds are safe and that so far as possible all the resources of science, engineering and experience are being brought to bear upon the problem. The future of air navigation is full of promise, and in that future the airship has its place distinct from that of the airplane. It is surely fitting that the United States, which gave to the world its first successful airplane, should actively advance man's final mastery of the air.

ATMOSPHERIC DUST: IS IT HELPFUL OR HARMFUL?

By Dr. HERBERT H. KIMBALL

METEOROLOGIST, UNITED STATES WEATHER BUREAU, WASHINGTON, D. C.

THIS story is not going to be exciting, so my radio audience will be able to keep on breathing in a natural way; and those of you who are normal adults will inhale about twenty times a minute, and with each breath will draw about thirty cubic inches of air into your lungs, or six hundred cubic inches in a minute.

We are going to examine the solid particles, usually called dust, contained in the air we breathe. I will ask you to go with me to the campus of the American University, four miles northwest of the White House, on a ridge three hundred feet higher than the business section of Washington. During the World War the Chemical Warfare Service had its headquarters and experimental laboratories in this campus. The government still retains some of the laboratories, and in one of them we will examine samples of dust collected from the atmosphere.

It is a clear frosty morning, so my records say, of a particular April day, with little wind and a beautiful blue sky. To the north Sugar Loaf Mountain, thirty miles distant in Maryland, is distinctly visible, and we can also distinguish peaks of the Blue Ridge fifty miles to the west in Virginia. In the valley to the east and south, however, where the nearby cities of Washington and Alexandria should be clearly seen, we look out upon a murky cloud, the upper surface of which is only slightly undulating, and through which protrude the tops of the towers of the Arlington radio station. Presently, as the sun begins to warm the surface of the ground, the cloud rises and envelops the university, reducing the limit of visibility to three quarters of a mile.

On January 16 of this year, a cold, calm and clear day, at 10 a. m., hills to the north in Maryland ten miles distant were visible. To the east and south, however, Washington and Alexandria were again hidden from view. On Pennsylvania Avenue in Washington it was so dark that street cars and automobiles used headlights, while government and private offices resorted to artificial lighting.

What was there in the atmosphere of the city on that beautiful April morning that reduced the limit of visibility from fifty miles to three fourths of a mile? And what did it contain on the morning of January 16 that reduced the daylight intensity to that of twilight? The odor told us that at least a part was coal smoke, and I think you will be interested in the examination of the particles that make up the smoke.

We will collect the dust contained in a measured quantity of air, using for this purpose an instrument modeled after our breathing apparatus. For the lungs we will substitute a suction pump: for our mouth, a small metal box; for our lips, a metal plate containing a small slot, and we will attach to this plate a tube lined with wet blotting paper, so as to saturate the air with moisture as it passes through. In the box, directly in front of the slot, we will place a small and very thin glass disk—a microscope cover glass is just the thing.

Now make the apparatus inhale by a quick pull on the piston of the pump. This movement of the piston produces a partial vacuum in the metal box, and as the air enters moisture is condensed on the dust particles that came in with it. This so increases their weight and stickiness that they strike the cover-glass and adhere to it. If we quickly remove the cover-glass we will see upon it a fine whitish line of moisture. This moisture quickly evaporates, but the dust, though invisible to the naked eye, remains on the glass.

In the examination of this dust we use a microscope that magnifies the diameters of the particles one thousand times, and their cross-section one million times. With it we can count dust particles having a diameter as small as 0.000008 inch. Smaller particles neither reflect light nor cast a shadow and therefore can not be seen. It would be a tedious task to actually count every particle in the fine line of dust; hence we measure its length and breadth, count the number of particles contained in two or three typical bands across it and then compute the number in the whole line.

Air brought to the university from the open country by a northwest wind con-

tains about two thousand dust particles per cubic inch; that on an average morning at the university during the winter of 1925–26, about thirty thousand, and that from the smoky air of Washington about 115,000. During this winter, air in the northwest suburb has contained about fifteen times as many particles of solid matter as air from the country, and the air from the smoky city about sixty times as many. But 115,000 dust particles per cubic inch is not an unusual number for the atmosphere of large cities where bituminous coal is burned. In fact, five times this number is sometimes found.

Furthermore, the dust found in country air consists principally of finely powdered mineral matter, irregular in shape, which is taken up from the surface of the ground by the wind; a few crystals, principally salt, and in the warm months of the year pollen from plants and spores from rusts or molds. In the suburbs there are added to the country dust the products of combustion, such as soot and ash and compounds both of sulphur and tar. In the city there is an increase in the combustion products and also dust from building operations.

The average diameter of country dust particles is about two one hundred thousandths of an inch; that of suburban dust about twice, and that of city dust about three times as great. The entire two thousand particles from a cubic inch of country air if in a straight row and touching one another would form a line only .04 inch in length; those from suburban air would span 1.2 inches, while those from the city air would make a string 6.9 inches long. The suburban dust line is thirty times and the city line 170 times as long as that from the open country. The volume of dust from suburban air is 120 times, and that from city air is 1,550 times that from the country.

As to the actual mass of solid particles in smoky air; in the city of Pittsburgh in one year the fall of soot from the atmosphere was over one thousand tons per square mile, or enough for the whole city to make a close string of loaded ash carts 250 miles long. This was before the Mellon Institute of the University of Pittsburgh had developed methods of smoke prevention which have since been adopted with gratifying results.

Can any good come from the presence of dust in the atmosphere? Returning to our dust counter, when the air was cooled by expanding in the metal box between the dampening tube and the pump, the surplus moisture condensed on the dust particles. Had there been no dust particles there would have been little or no condensation. The same is true in nature. When air rises to pass over a mountain, for instance, it often cools to such an extent as to become saturated with moisture. Moisture will then begin to deposit on the dust particles in the air, forming a cloud, from which rain may fall. In the absence of dust particles there would be practically no condensation, no cloud and no rain. Fortunately, there always are sufficient dust particles in the air everywhere to form the necessary nuclei for condensation.

A smoke cloud, if dense, will retard the cooling of the atmosphere below it during the night. In fact, fruit growers formerly thought it necessary to form such a cloud over their orchards to protect them from damage when frost threatened. We now know that more effective protection is afforded by burning the fuel and thus producing heat to raise the temperature of the air in the orchard, rather than by forming an objectionable smoke cloud to prevent cooling. So we can not claim any virtue for smoke on the ground that it keeps the cities warm. Rather, it is an indication of an unnecessary waste of fuel.

But is smoke actually harmful? Certainly it is a nuisance because it is so filthy. It is an expense, because when it becomes dense, as on January 16 last, it diminishes the intensity of daylight to less than a quarter of that on a clear day,

and increases our bill for lighting. Furthermore, the city dweller wants to know what becomes of the sixty-nine million solid particles he often breathes in a single minute. If he breathes through his nostrils they will act very much like our cover glass in the dust counter and collect the dust particles, as his handkerchief is apt to show him. If he breathes through his mouth many of the particles will lodge in his lungs. Examination of the lungs of persons who had resided for a long time in smoky cities has shown them to be blackened by the soot from the air. Just what effect this may have upon health is for the medical profession to say. Some authorities claim that so much soot and dust increases our susceptibility to disease and especially to pneumonia. Furthermore, it cuts out from sunlight practically all the ultra-violet, which is known to be a powerful germicide. In consequence hospitals in large cities are equipped to treat diseases like rickets under artificial ultra-violet light, and sanitariums for the treatment of pulmonary diseases are built on mountains or plateaus where the ultra-violet component in sunlight is especially strong.

Does smoke produce fog? There are always a sufficient number of dust particles in the air to bring about condensation of moisture if the air is saturated. Some products of combustion are hygroscopic. That is, they absorb moisture, and may cause a light fog in air not completely saturated. Also, the presence of smoke particles in fog greatly increases its density and retards its dissipation. It is for these reasons that London has days of almost complete darkness due to the density and persistence of its black fogs.

A smoky atmosphere usually results from the general use of bituminous coal, especially for heating dwellings. It is noteworthy that the number of smoke particles in the air at the American University in the suburbs of Washington this winter is more than double the number for any previous winter. It is possible, however, to minimize, if not entirely remove, the smoke nuisance. Intelligent stoking of furnaces will do much. In addition, Dr. Cottrell, director of the Nitrogen Fixation Laboratory on the campus of the American University, has devised an electrical method of precipitating the solid particles in smoke before they leave the stack. There are other methods of preventing city smoke, all somewhat expensive. We are therefore called upon to decide whether we are willing to incur the trouble and expense necessary to insure clean air for city dwellers. Stated in another way, do we not prefer to spend time and money to keep the air of our cities clean rather than to suffer from the damage to health and property that results from the contamination of the air by smoke?

DAVID DOUGLAS

FROM A PENCIL DRAWING BY HIS NIECE, MISS ATKINSON

WHERE DOUGLAS PIONEERED

By Major JNO. D. GUTHRIE

U. S. FOREST SERVICE, PORTLAND, OREGON

ONE hundred years ago David Douglas, the young Scottish botanist, was exploring in the Pacific Northwest. By these explorations he added greatly to the sum of botanical and forestry knowledge of the Pacific coast. Had he nothing more as a monument, his name will ever live in the great Douglas fir forest of the west coast.

The list of American trees and plants which bears his name after their specific nomenclature is a long one. Sugar, western white, western yellow and digger pines, lovely and silver firs, are only a few; the list of plants and shrubs discovered and described by Douglas runs into the hundreds. His botanical explorations on the Pacific coast were truly those of a pioneer. His privations and self-sacrifice for science in the Oregon country of 1823 to 1830 were the more real ones because they had not for their goal material wealth, the common goal of men of that day and region. His too brief life reads like a romance.

He was but twenty-five years old when he first set out in 1823 from Liverpool for America. Born with a love for plants, he had served a seven-year apprenticeship as gardener to the Earl of Mansfield, followed by two years at Valleyfield, near Culross, where there was a notable collection of exotic plants. Then he received an appointment in the Glasgow Botanic Gardens where he came under the eye of Dr. William Hooker, the well-known botanist of that day. The Royal Horticultural Society became interested in the country of the Hudson's Bay Company and asked Dr. Hooker for recommendations as to a suitable person to be sent by the society on a botanical expedition to North America. It is significant of his botanic knowledge and qualifications as a scientist that young Douglas was recommended and appointed. He set out on June 3, 1823.

The results of his first mission, which was confined to the Atlantic seacoast,

THIS TABLET MARKS THE FINAL RESTING PLACE OF DAVID DOUGLAS.
IT IS ON THE CORNER OF THE "KAWAIAHAO" (CORAL STONE CHURCH) IN HONOLULU.

THE UNWEARIED TRAVELER TARRIES HERE AT LAST.
Photo by Board of Agriculture & Forestry, Honolulu.

was a large number of specimens of oaks. This collection he took back to England late in 1823.

He first came into the Columbia River on April 8, 1825, in the Hudson's Bay Company's ship *William and Anne,* after a trip of eight months and fourteen days from England. Dr. John Scouler was the ship's surgeon, also a naturalist of note.

Even before landing at Baker's Bay, near the mouth of the Columbia River, Douglas made a botanical entry in his journal: "The ground on the south side of the river is now, covered thickly with wood, chiefly *Pinus canadensis, P. balsamea,* and a species which may prove to be *P. taxifolia.*" Here was his first sight of the tree later to bear his name, Douglas fir, though he called it a pine, as well as the western hemlock and the lovely fir. On the 19th, he set out with the famous Dr. John McLoughlin, "the Father of Oregon," up the river on an expedition. His journal bristles with new plants and trees. Under that date he again mentioned Douglas fir, saying:

> I measured one lying on the shore of the river . feet in circumference and 159 feet long; the top was wanting, but at the extreme length 2½ feet in diameter, so I judge that it would be in all about 190 feet high if not more, girth 48 feet; they grow very straight; the wood is softer than most of the *Pinus* except *P. canadensis,* and easily split. The species, although I have not yet seen the cones, I take to be *P. taxifolia,* the most common tree in the forest.

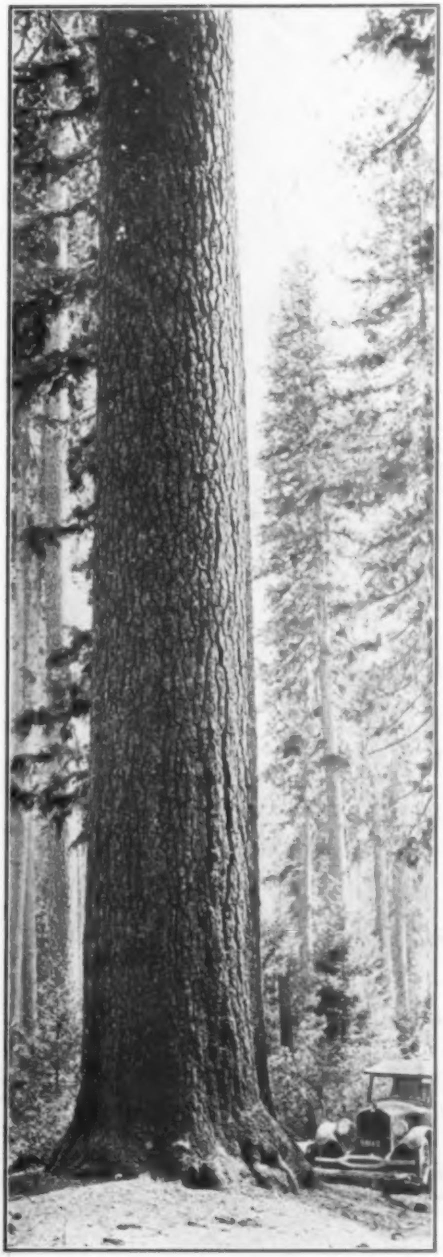
Douglas was a real pioneer. He spent three years in the Pacific Northwest, with the company's expeditions, with Indian guides, and alone, in this wilderness. He endured the severest kind of hardship, going hungry and sleeping cold and wet night after night in order that by depriving himself of cover he might carry paper for pressing his specimens and for keeping his notes. On many of his trips he had a bearskin and a single blanket for a bed, and finally, in the heavy rains, used his precious bearskin to wrap and protect his specimens. He had fever often when alone out in the trackless Oregon woods, and bled himself to relieve his temperature. He risked his life again and again, by flood and cliff, and with unfriendly Indians of that day.

Perhaps the most interesting of all the young Scot's finds are the Douglas fir and the sugar pine. Douglas fir, it is true, was first described by Captain Meriwether Lewis on the history-making trip with Clark, but the tree was not named until David Douglas' specimens arrived in England. First called *Pinus douglasii*, it was soon recognized that it did not have the characteristics of the pine. This tree passed through a varied nomenclature until it was finally named *Pseudotsuga taxifolia*, false hemlock. It has borne, and still does, a large number of common names, Oregon pine, red fir, yellow fir and others. Only in the English or common name is the real discoverer of the tree honored.

Douglas' finding of the sugar pine reads like a true pioneer's tale. He had first seen a few seed of this tree in an Indian's pouch near Oregon City. Scientist that he was, they instantly attracted his attention. The Indian told him that they came from a tall tree that grew far to the south. As is shown by many references in his journal, Douglas did not rest until he had seen this forest monarch. He had started south with one of the company's expeditions towards the Umpqua. The party turned west to follow the course of the river to the sea. Douglas, with an Indian youth as guide, went south and camped near the junction of Elk Creek and the Umpqua River.

On this first trip he was unsuccessful. He made a second exploring trip and found his pine, probably on what is now known as Sugar Pine Mountain, near Roseburg. Let him tell the story in his own words, as given in his Journal of Oct. 1826:

Thursday, 26th. Weather dull and cloudy. When my people in England are made acquainted with my travels, they may perhaps think I have told them nothing but my miseries. That may be very correct, but I know now that such objects are not obtained without a share of labour, anxiety of mind, and sometimes risk of personal safety. I left my camp this morning at daylight, on an excursion,



PINUS.

AT MIDDAY I REACHED MY LONG-WISHED PINUS (CALLED BY THE UMPQUA TRIBE NATALE). THIS MAY HAVE BEEN THE TREE UNDER WHICH DOUGLAS PARLEYED FOR HIS LIFE WITH THE INDIANS.

Photo by Board of Agriculture & Forestry, Honolulu.

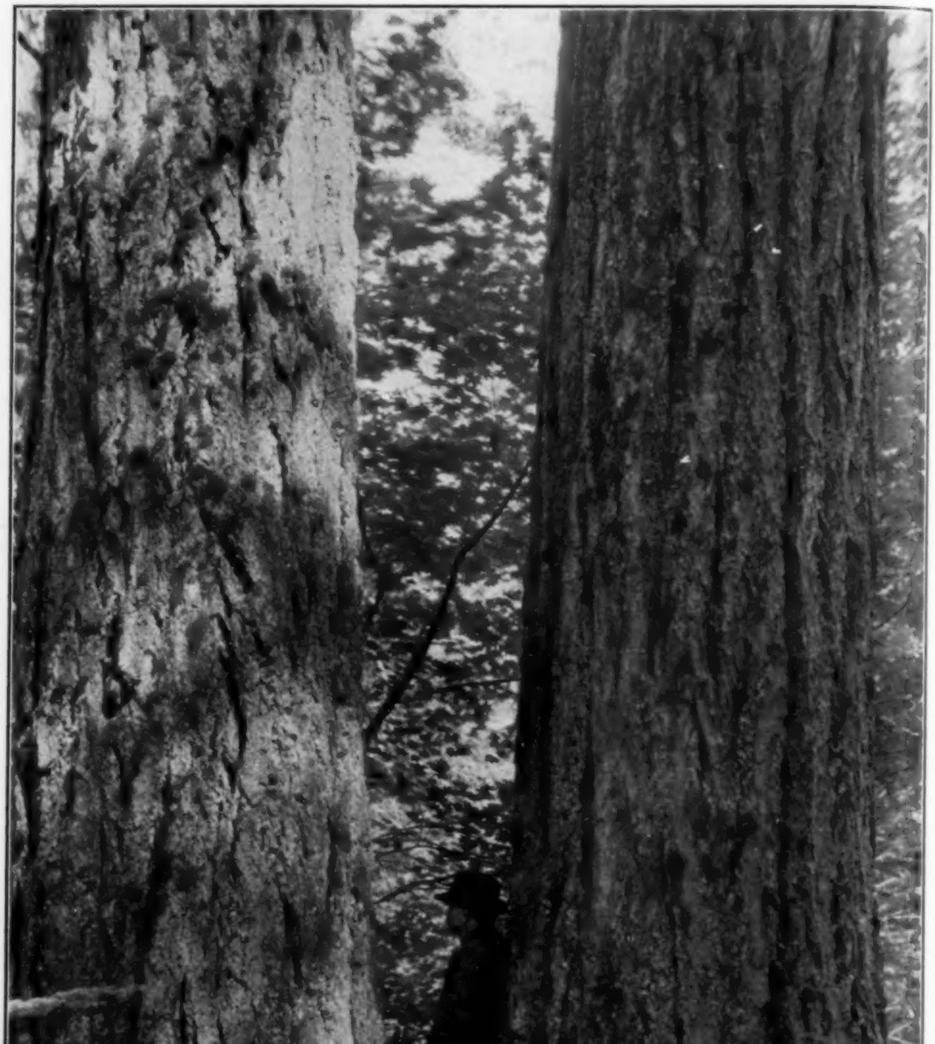


Photo by Weister

THE GREAT DOUGLAS FIR

HIS NAME WILL EVER LIVE IN THE GREAT DOUGLAS FIR FOREST OF THE WEST COAST.

leaving my guide to take care of the camp and horses until my return in the evening, when I found everything as I wished; in the interval he had dried my wet paper as I had desired him. About an hour's walk from camp I was met by an Indian, who on discovering me strung his bow and placed on his left arm a sleeve of raccoon-skin and stood ready on the defence. As I was well convinced this was prompted through fear, he never before having seen such a being, I laid my gun at my feet on the ground and moved my hand for him to come to me, which he did with great caution. I made him place his bow and quiver beside my gun, and then struck a light and gave him to smoke and a few beads. With my pencil I made a rough sketch of the cone and pine I wanted and showed him it, when he instantly pointed to the hills about 15 or 20 miles to the south. As I wanted to go in that direction, he seemingly with much good will went with me.

At midday I reached my long-wished *Pinus* (called by the Umpqua tribe *Natàle*), and lost no time in examining and endeavoring to collect specimens and seeds. New or strange things seldom fail to make great impressions, and often at first we are liable to over-rate them; and lest I should never see my friends to tell them verbally of this most beautiful and immensely large tree, I now state the dimensions of the largest one I could find that was blown down by the wind: Three feet from the ground, 57 feet 9 inches in circumference; 134 feet from the ground, 17 feet 5 inches; extreme length, 215 feet. The trees are remarkably straight; bark uncommonly smooth for such large timber, of a whitish or light brown colour; and yields a great quantity of gum of a bright amber colour. The large trees are destitute of branches, generally two-thirds the length of the tree; branches pendulous, and the cones hanging from their points like small sugar-loaves in a grocer's shop, it being only on the very largest trees that cones are seen, and putting myself in possession of three cones (all I could) nearly brought my life to an end.

Being unable to climb or hew down any, I took my gun and was busy clipping them from the branches with ball when eight Indians came at the report of my gun. They were all painted with red earth, armed with bows, arrows, spears of bone, and flint knives, and seemed anything but friendly. I endeavored to explain to them what I wanted and they seemed satisfied and sat down to smoke, but had no sooner done so than I perceived one string his bow and another sharpen his flint knife with a pair of wooden pincers and hang it on the wrist of his right hand, which gave me ample testimony of their inclination. To save myself I could not do by flight, and without any hesitation I went backwards six paces and cocked my gun, and then pulled from my belt one of my pistols, which I held in my left hand. I was determined to fight for my life. As I as much as possible endeavored to preserve my coolness and perhaps did so, I stood eight or ten minutes looking at them and they at me without a word passing, till one at last, who seemed to be the leader, made a sign for tobacco, which I said they should get on condition of going and fetching me some cones. They went, and as soon as out of sight I picked up my three cones and a few twigs, and made a quick retreat to my camp, which I gained at dusk. The Indian who undertook to be my last guide I sent off, lest he should betray me. Wood of the pine fine, and very heavy; leaves short, in five, with a very short sheath bright green; cones 14½ inches long, one 14, and one 13½, and all containing fine seed.

Notice how the pioneer, having disposed of the Indians at the risk of his life, is again the scientist, describing in detail his new-found treasure!

The very next day his guide, about daylight while fishing, was attacked by a grizzly bear. Douglas went out later and found a large female, with two cubs. He shot one of the cubs and the mother, paying off his guide with the carcass of the young. He naïvely puts this down in his journal:

I abandoned the chase and thought it prudent from what happened yesterday to bend my steps back again without delay. So I returned and crossed the river two miles further down, and camped for the night in a low point of wood near a small stream. Heavy rain throughout the day.

This is but one episode of his life in the Oregon country of 1825. He went up the Columbia River as far as Kettle Falls, to Fort Spokane, and to Fort Colville, and back again, through hostile Indian country, boating at night for safety; he climbed Mount Adams twice within a few days; he traveled along the coast, and high up in the Cascades. He made three trips into the Blue Moun-

tains of eastern Oregon, he ascended Lewis and Clark Fork, back to Fort Spokane, thence overland to Okanogan, and back to Fort Vancouver. He sets down the estimated distances traveled as 2,105 miles in 1825, 3,932 in 1826 and 995 in 1827. He was interested in everything he saw, identifying and recording the fauna and flora, regardless of personal privation, lack of food, the rains or hostile Indians. At every opportunity he sent back to England the specimens and notes he was industriously collecting.

In January, 1827, after most carefully packing many precious specimens, which he had placed on the ship's invoice as "dry plants, seeds, preserved animals, and articles relating to natural history" for the Horticultural Society of London, he set out for Hudson's Bay! His companions were fifteen voyageurs, Hudson's Bay men, including four Canadians and three Iroquois Indians. Carrying on his back a tin box containing many seeds and his journals, he left Fort Vancouver on January 20, on "the annual express across the country," as he called it. What a journey that was, in the middle of winter! His account of this trip is filled with adventure, hardship and intense interest. Up the Columbia by Okanogan, Fort Colville, Kootenai River, on to the head of the Columbia River. After leaving the river because of its rapids, the party followed the trail afoot, on snowshoes, over snow-covered country to the northward-flowing streams, fording and refording the icy waters, all the time with his sacred tin box on his back.

Deep snows hid plants, but he was busy identifying the trees and collecting mineral specimens and worrying because he could not save numberless specimens of grouse, ptarmigan, fox, deer, caribou and bear. But he carried with him for over two thousand miles of this journey a fine specimen of the bald eagle, on whose accidental death he remarks: "What can give one more pain?"

He tarried at the posts on the Assiniboine River, still collecting, and at Norway House met Sir John Franklin returning overland from his second Arctic expedition. Douglas continued for Hudson's Bay on August 10, arriving there on August 28, most pleased to see the company's ship from England in the bay, on which he sailed for the homeland on September 15, 1827.

From the transactions of the Horticultural Society we learn that from the specimens and seeds which Douglas had sent home, 210 distinct species had been grown in the society's gardens, 130 of which were later "distributed to all parts of the world."

Douglas made several trips later, into the Columbia region, south to California and later tarried in the Hawaiian Islands, to his untimely death. He seems to have broken with the London society during this time, and his journals are not available, so that there is an unfortunate gap in his life.

The tragic nature of the untimely death of this brilliant young naturalist is a climax to his years of hardship and danger in the northwest country. Intensely interested in the new and tropical flora of the Sandwich Islands, he set out alone to go into the mountains from an Englishman's ranch in search of new plants, accompanied by a little dog. It will never be known how nor why, for he had been shown them, but somehow he fell into a pit dug by the natives for catching wild cattle, into which there had evidently fallen previously a wild bull. His mutilated remains were found the following day (August 13, 1834) and nearby his plant-case and the faithful little dog. English missionaries brought his body to Honolulu and buried it.

Thus at the early age of thirty-six did David Douglas give his life, but science was far richer for his having lived and pioneered in her behalf in the great Pacific Northwest.

BUST OF DR. WILLIAM H. WELCH

DIRECTOR OF THE SCHOOL OF HYGIENE AND PUBLIC HEALTH AT THE JOHNS HOPKINS UNIVERSITY, UNVEILED ON FEBRUARY 22, ON THE OCCASION OF THE COMMEMORATION DAY EXERCISES OF THE UNIVERSITY. DR. SIMON FLEXNER, DIRECTOR OF THE ROCKEFELLER INSTITUTE, MADE THE PRESENTATION SPEECH.

THE PROGRESS OF SCIENCE

DR. HORNADAY'S RETIREMENT AS DIRECTOR OF THE NEW YORK ZOOLOGICAL PARK

At the annual spring meeting of the board of managers of the New York Zoological Society, which was held in the Administration Building of the park on May 20, Dr. William T. Hornaday, who has recently completed thirty years of distinguished service as director of the New York Zoological Park, announced his retirement, to take place on June 1. When Dr. Hornaday announced his retirement, Professor Henry Fairfield Osborn, until 1924 president of the Zoological Society, offered the following resolution, which was unanimously adopted:

THE NEW YORK ZOOLOGICAL SOCIETY
Chartered April 26, 1895

The New York Zoological Society in its thirty-first year records its appreciation of
WILLIAM TEMPLE HORNADAY
planner and director of the New York Zoological Park since April 6, 1896; naturalist, nature lover, learned and voluminous author; zealous friend and protector of the wild life of North America.

Chosen in 1896 as the best qualified expert in the United States in zoologic park planning and administration, Dr. Hornaday studied all the great zoological parks of Europe, discovered the peculiar fitness of the South Bronx Park, transformed the meadow land and wild forest, and submitted the first General Plan in accord with the three great principles previously established by our Society:

The establishment of a free zoological park containing collections of North American and exotic animals, for the benefit and enjoyment of the general public, the zoologist, the sportsman and every lover of nature.

The systematic encouragement of interest in animal life, or zoology, amongst all classes of the people, and the promotion of zoological science in general.

Cooperation with other organizations in the preservation of the native animals of North America, and encouragement of the growing sentiment against their wanton destruction.

As administrative director of the New York Zoological Park for thirty years, Dr. Hornaday imparted, by his own example, continued intelligence, energy and enthusiasm, and inspired his increasing staff with loyalty and devotion to the spirit of public service, thus creating the largest and most beautiful, the most popular and the most widely known zoological park in the world.

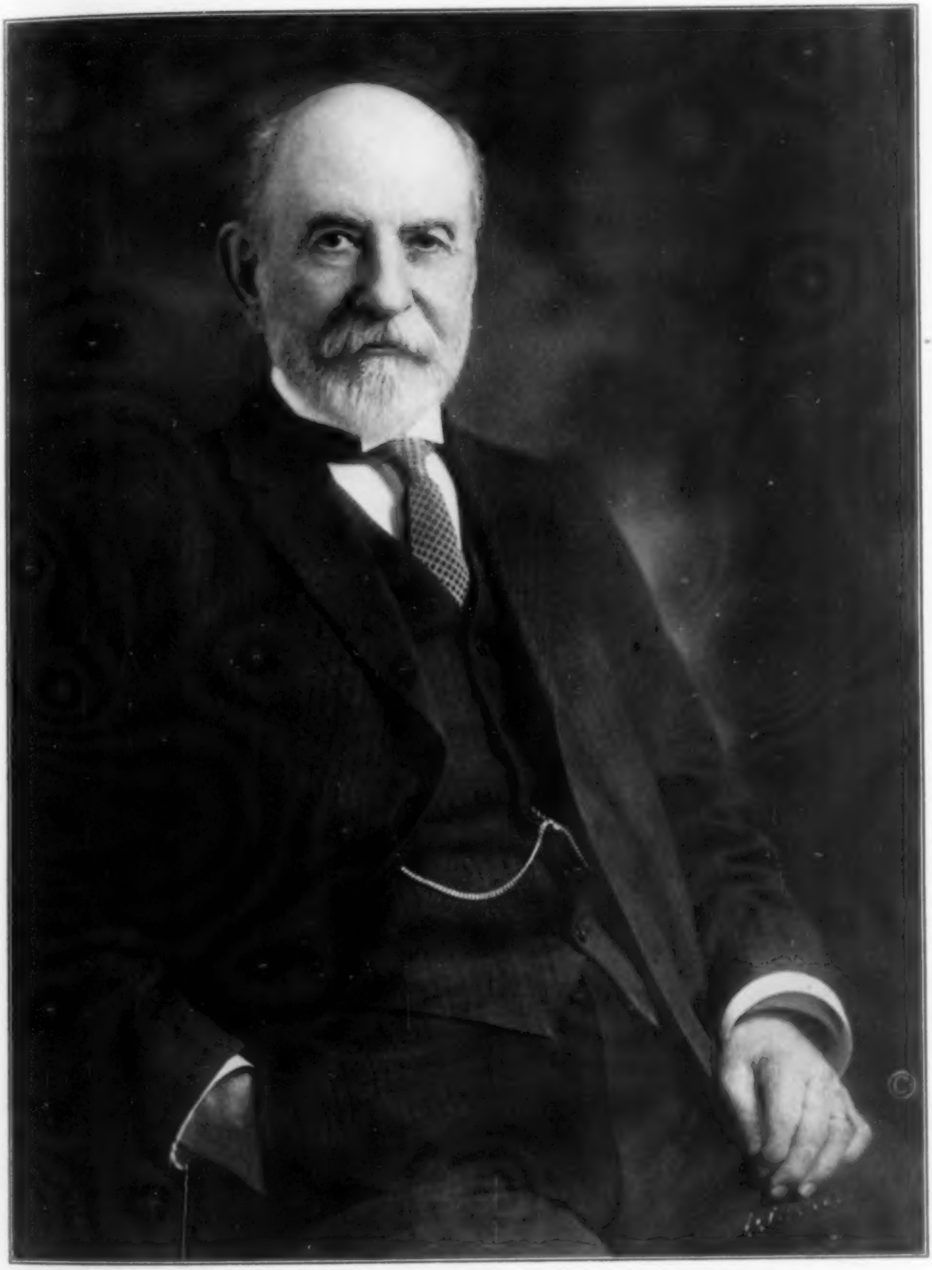
For these manifold services to public education and to zoology, the members of the
BOARD OF MANAGERS
make this permanent and grateful record of their appreciation, esteem and friendship.

The idea of a Zoological Park originated in the Boone and Crockett Club, in the autumn of 1894. On January 16, 1895, Theodore Roosevelt, president of the club, appointed a committee of three—Messrs. Elihu Root, C. Grant La Farge and Madison Grant, chairman—who persisted in the State Legislature until a charter was secured. The enabling act which brought the Zoological Society into corporate existence was successfully passed through the New York State Legislature by Mr. William White Niles, a member of the society, who, fortunately, at that time was a member of the assembly.

The New York Zoological Society started out with the purpose of extending and cultivating in every possible manner for the people of the City of New York a knowledge and love of nature. The initial objects of the society, expressed in the charter of 1895, were the following:

> Said corporation shall have power to establish and maintain in New York City a zoological garden for the purpose of encouraging and advancing the study of zoology, original researches in the same and kindred subjects, and of furnishing instruction and recreation to the people.

The act to incorporate the New York Zoological Society, and to provide for the



W. T. HORNADAY

DR. WILLIAM T. HORNADAY AND DR. W. REID BLAIR

IN THE NEW YORK ZOOLOGICAL PARK WITH THE FIRST MUSK-OX CALF TO BE BORN IN CAPTIVITY.

establishment of a zoological garden in the City of New York was accepted by the city, and became a law on April 26, 1895.

Dr. Hornaday was appointed director of the newly formed Zoological Society on April 1, 1896, and after making a complete study of the various available parks in New York City brought to the attention of the Executive Committee the fact that the southern half of Bronx Park offered an ideal site for the proposed Zoological Park.

Here he found a wonderful combination of hill, of high ridge and deep valley, of stream and pond, rolling meadow, rocky ledge and virgin forest, of the finest description, all of which, by a happy combination of circumstances, had been preserved intact for many years. After the city authorities set aside Bronx Park as a site for the Zoological Park, Dr. Hornaday drew up a general plan in which he endeavored to preserve all the natural features of the park, so far as possible without cutting any of the fine trees. This plan provided for an inner circle of large, permanent buildings, and an outer circle of large, semi-wild natural enclosures, consisting of ranges of from two to twenty acres in extent. It is interesting to compare the plan for the Zoological Park as adopted unanimously by the Executive Committee on November 9, 1897, with the Zoological Park today, and to note how very few changes have been made, and these only in minor details.

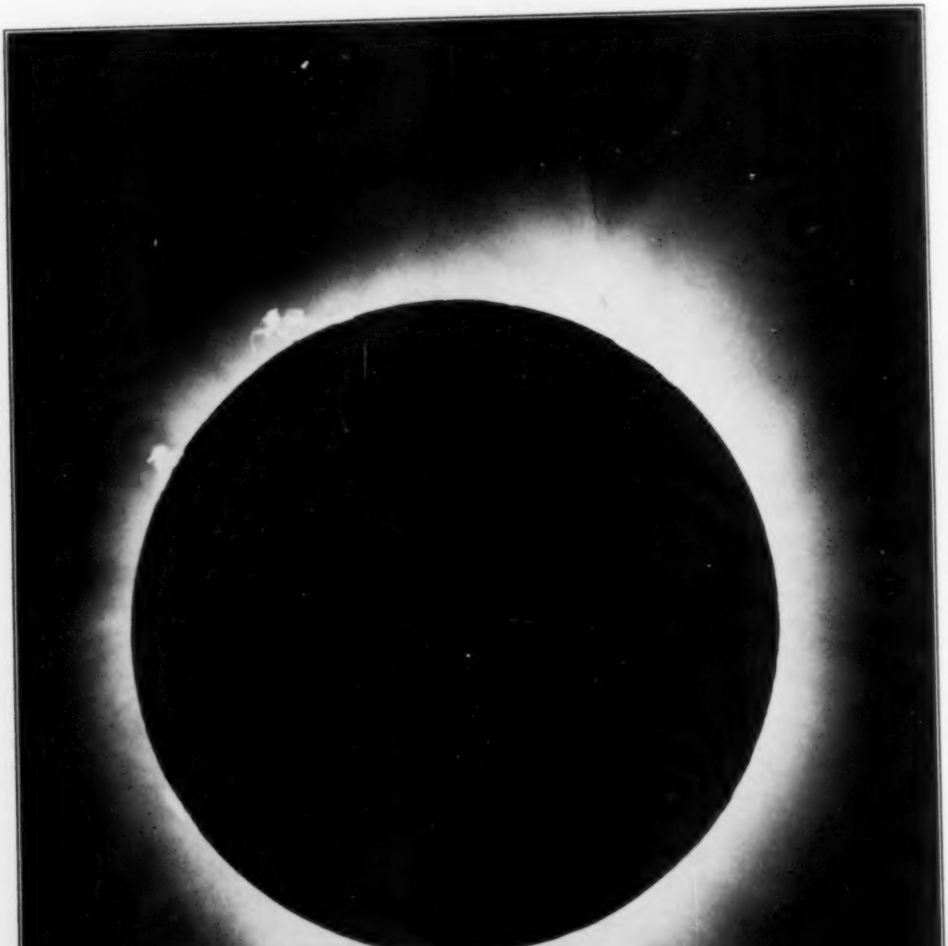
The active work of building the Zoological Park began on August 15, 1897, and continued during the next eighteen years. The Zoological Park was opened to the public on November 8, 1899. From that date to this the total attendance has been about 44,000,000. When the grand rush of construction in 1899 ended with the formal opening of the unfinished Zoological Park on November 8, 1899, the entire collection of twenty-two installations for mammals, birds and reptiles had been created by the Zoological Society at the expense of its own treasury. Automatically they became the property of the city as fast as they were completed.

On June 10 the Zoological Society presented to Dr. Hornaday a gold medal as a tribute to his thirty years of service. In presenting this medal Mr. Grant, the president of the society, spoke of Dr. Hornaday's intimate knowledge of wild animals in their native haunts, acquired during his world-wide travels before he took charge of the Zoological Park.

"There have been plenty of men who were hunters, Indian hunters and frontiersmen in our own country, who knew the animals in their wild state," Mr. Grant said, "but they were not men of training and observational ability, to mark down, interpret and record what they saw. Dr. Hornaday was one of the last to be able to see wild life in its former state, and one of the first who had the education, the training, the industry and interest to put those facts on record."

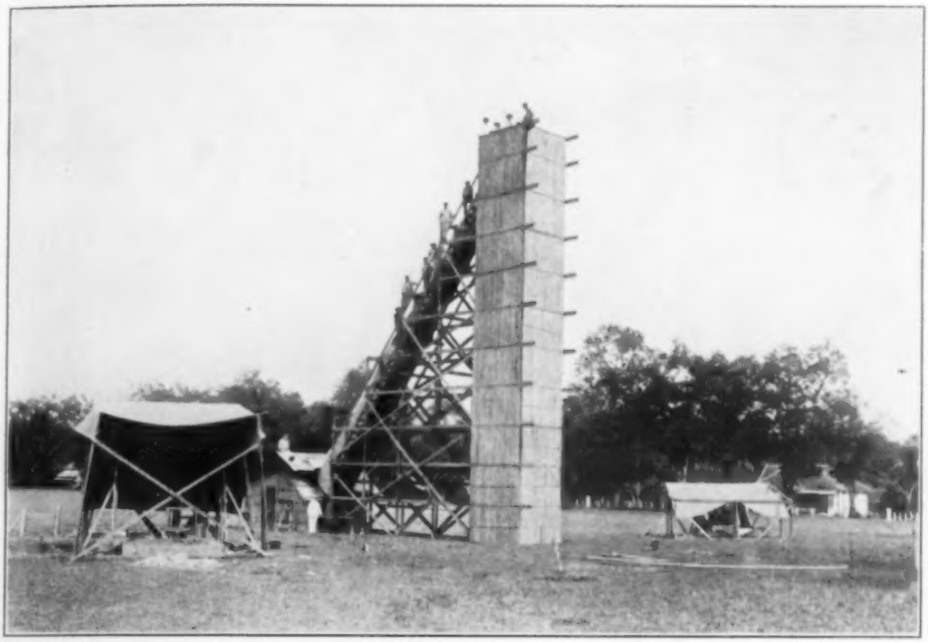
Dr. W. Reid Blair, who succeeds Dr. Hornaday as director, is of Scotch ancestry, and was born in Philadelphia, January 27, 1875. He was graduated from the department of comparative medicine and veterinary science of McGill University in 1902. While in college he specialized in comparative anatomy, pathology and psychology, acting as secretary of the Society for the Study of Comparative Psychology founded by the noted psychologist and physiologist, Professor T. Wesley Mills, of McGill University.

Immediately upon graduating, Dr. Blair accepted a position on the scientific staff of the New York Zoological Park for the purpose of studying the diseases of wild animals in confinement. He has made numerous contributions to scientific publications dealing with the comparative pathology of wild animals.



THE SOLAR CORONA.

PHOTOGRAPH TAKEN WITH THE 65-FOOT FOCAL LENGTH CAMERA BY E. C. BRAUER, CHIEF PHOTOGRAPHER OF THE UNITED STATES NAVY. HALF SIZE OF THE ORIGINAL PLATE.

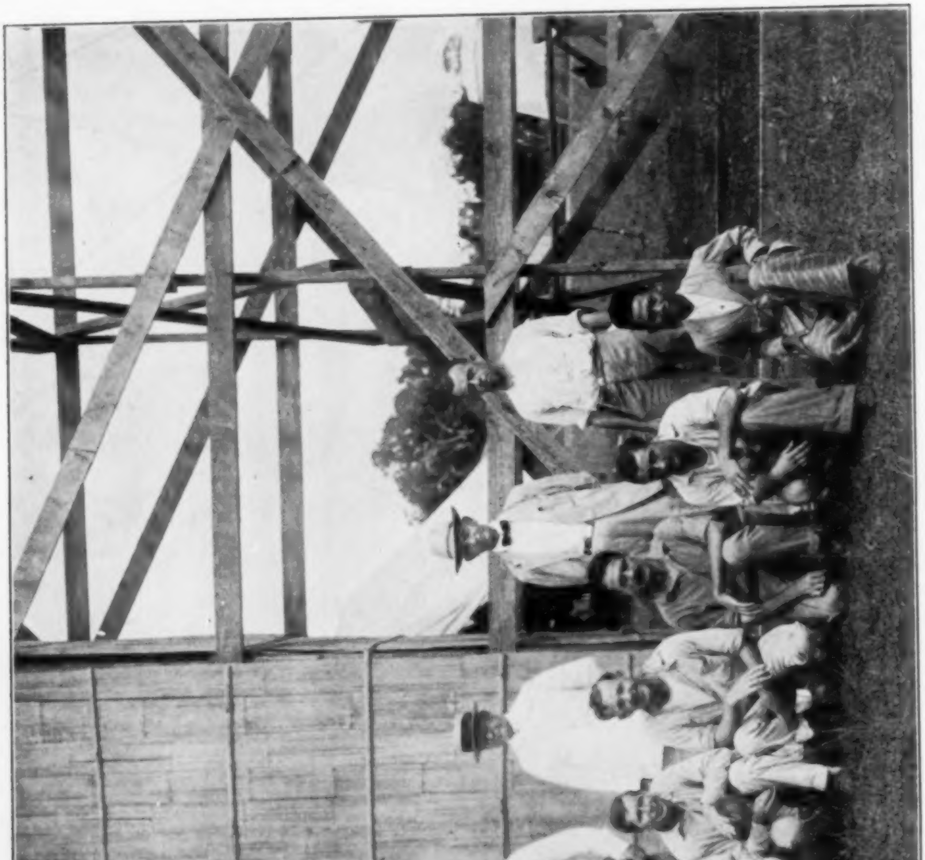


GENERAL VIEW OF THE STATION AT KEPAHIANG, SUMATRA.

From 1905 until 1917, Dr. Blair was professor of comparative pathology in the veterinary department of New York University. During the World War he was commissioned major in the Veterinary Corps of the U. S. Army, serving in France and Germany as chief veterinarian of the Fourth Army Corps. He now holds a colonel's commission in the Officers' Reserve Corps. He has been assistant director of the New York Zoological Park since 1922.

THE U. S. NAVAL OBSERVATORY ECLIPSE EXPEDITION TO SUMATRA

IN the quest of eclipse observations astronomers have journeyed to the far ends of the earth, but it must be very rarely that the same astronomers have traveled a second time over the same route to almost the same place half way round the globe to witness and observe this most wonderful and awe-inspiring phenomenon. This happened in the case of two of the astronomers of the U. S. Naval Observatory expedition to observe the recent total solar eclipse of January 14, 1926, in the Island of Sumatra. In 1901 they occupied stations near the middle of the island, and in 1926 in the southwestern part, in the little village of Kepahiang, 35 miles from the well-known seaport town of Benkoulen, at which place several other parties were located. Captain F. B. Littell, Corps of Professors of Mathematics, U. S. Navy, who had observed the eclipse of 1901, in Solok, was in charge of the expedition, and Associate Astronomer G. H. Peters, who had observed the 1901 eclipse in Fort de Kock, accompanied him. With them were Dr. J. A. Anderson, of the Mt. Wilson Observatory, also a veteran eclipse observer, who was in charge of all the spectrographic work, and Assistant Astronomer G. M. Raynsford, of the Naval Observatory. Lieutenant H. C.



GROUP OF ASTRONOMERS, SAILORS AND MALAY ASSISTANTS ASSEMBLED AT THE BASE OF THE STATION. THOSE STANDING (FROM LEFT TO RIGHT) ARE F. B. LITTELL (IN CHARGE), CAPT. U. S. NAVY (MATH.); DR. H. C. KELLERS, LIEUT. MEDICAL CORPS, U. S. NAVY (IN CHARGE OF SMALL POLAR AXIS); G. H. PETERS, ASSOCIATE ASTRONOMER, NAVAL OBSERVATORY (IN CHARGE 65 FT. INST.); DR. J. A. ANDERSON, PH.D., PHYSICIST, LAB. MT. WILSON SOLAR OBSERVATORY, PASADENA, CALIF.; G. M. RAYNSFORD, ASST. ASTRONOMER, NAVAL OBSERVATORY (IN CHARGE LARGE POLAR AXIS).

Kellers, Medical Corps, U. S. Navy, was a member of the expedition, and in addition represented the Smithsonian Institution in collecting entomological and zoological specimens. A party of seven enlisted men of the navy was detailed to assist in the work of erection of instruments, and in the observations of eclipse day.

While the Island of Sumatra may be described as being in a somewhat backward state of civilization, much progress was noted as compared with the condition twenty-five years ago. The economic condition seemed to be very prosperous, due to the high prices of rubber and coffee, and the exploitation of extensive petroleum deposits. It was feared that transportation beyond the hundred miles of railroad might still have to be made by the primitive ox- or carabao-cart of the olden times, which while sure was tantalizingly slow. However, it was found that automobile transportation service was maintained over good roads across the island, and rapid progress was assured. There is government ownership of railroad and auto truck transportation service, and by the courtesy and generosity of the Dutch government all eclipse expeditions with their apparatus were transported without charge from the port of debarkation to their destinations. The courtesy and helpfulness of the Dutch officials and residents of the island can not be too highly commended.

It was well known that all eclipse expeditions going to observe this eclipse were taking a long sporting chance on the weather, for it occurred in the middle of the rainy season. From the data available it appeared that the chance of favorable weather was about one in three. Taking account of its previous experience in 1901, the Naval Observatory located in a somewhat elevated region just east of the first range of mountains that follow the west coast. The weather conditions there proved to be about as expected, or a little less favorable, as to cloudiness. The temperature was quite comfortable on the whole, the extreme range being from 64° at night to 90° in the afternoon. During the rainy season there were intervals of comparatively good weather, and the day of the eclipse was in the midst of such an interval. Yet just at the time of totality a cloud obscured the sun for two of the three precious minutes of its duration.

A number of excellent photographs of the eclipsed sun were obtained during the minute when it was shining through rifts in the cloud. The photographs taken with the 65-foot camera, which was pointed directly at the sun, show an abundance of interesting detail in the structure of the inner corona, and will repay careful study and discussion. On account of the partial obscuration by the cloud, no great extension of the corona was evident on the plates, and for the same reason the spectrographic plates were impressed by only a few of the strongest lines.

The moving picture apparatus, being readily transportable, was sent in an automobile to seek a region of clearer sky, and with it a good film was secured, showing the general features of the corona and considerable extension.

The first, third and fourth contacts were observed, giving the following corrections to the predicted times, I + 29.0 seconds, mean of two observers, III + 1.4 seconds, one observer, IV − 4.0 seconds, mean of two observers.

It is interesting to note that Sumatra is to be favored with another eclipse on May 9, 1929, with a duration of 5 minutes, which is considerably longer than that of this year.

Especial mention should be made of the elaborate arrangements made for the accommodation and comfort of all the

eclipse parties, due to the foresight and efforts of Director Vouté, of the Bossche Observatory, Lembang, Java, and of Mr. Kerkhoven, of Bandoeng, Java, Secretary of the Netherland-Indian Astronomical Society, and of the ever-helpful activities of Controleur Wink, of Kepahiang.

A "PSALM" OF LIGHT

By Beta

Tell me not in Einstein's numbers
Time is but an empty dream
And the space is dead that cumbers
And things are not where they seem.
Time is real, space is earnest
V o'er c is but a tool
With which thou perhaps discernest
But a jot of nature's rule.
ann/ Not Minkowski, no nor Riem~~en~~,
Framed our destined end or way;
Nor yet Maxwell nor his demon
Fix the ether or its sway.
Larmor's curls and Planck's equation
Order not one single flash,
Nor can Lorentz' transformation
Transcend mortal's mental hash.
Whims of wranglers all remind us
"As the twig, the tree's inclined."
And howe'er their bents may blind us
"Naught exists without the mind."
Wrangler's art is set on axioms,
Man-conceived, by man expressed
And like most of man's contraptions
May have faults when brought to test.
Let us then not be excited
Just because the starlight curves:—
Euclid's line was thought, not sighted.
Common sense, as ever, serves.